



FOCUS

SCIENCE AND TECHNOLOGY

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SUMMER Q&A SPECIAL

WHY OUR SUMMERS

Is sunshine good for you?

What is summer like on Mars?

Is BBQ food bad for your health?

Will holiday flights get shorter?

What's the best way to keep cool?

Why does cut grass smell so good?

BUGS IN YOUR BEDROOM

The unseen creepy crawlies living among us



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Is it still worth buying a camera? We test 3 compacts against the iPhone 5

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WELCOME TO FOCUS



WILL THIS SUMMER be a good one, or a return to the washouts of recent years? We'd all like to know – and here at *Focus* we've been wondering about future summers too. Is there a long-term trend at play? We asked Tom Heap, environment reporter for BBC TV's *Countryfile*, to find out.

While we were thinking about this, a few other summer-related questions started landing in our

inbox. So we compiled them into a summer-themed Q&A special. If you want to know how to keep your house cool or whether BBQ food is bad for you, turn to page 35.

The Tour de France is back this month, with Chris Froome and co doing battle on two wheels. But how does science help and hinder the combination of man and machine? James Witts investigates on p72. Also making a welcome return (to the pages of *Focus*) this month is Egyptology. Author Andrew Robinson explains how hieroglyphics were deciphered on p88.

Finally, we'd be grateful if you could spare a few minutes to fill in our new reader survey on p25. Tell us what you think about the contents of this issue and we'll give you more of what you want in future. Plus, you could win an iPad mini!

Until next issue,

Graham

Graham Southorn, Editor



PS Our new special issue **Earth From Space** is on sale now, priced £7.99. To order, visit buysubscriptions.com/earthfromspace

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APPEARING IN THIS ISSUE...



Emma Bayley

Our contributing editor ably compiles the Q&A section every month. But for this issue, things

were a little different – all the questions were about an ideal summer. Read the answers from p35, and let's hope the real weather delivers.



Adam Hart

An insect specialist at the University of Gloucester, Adam has become a familiar face on BBC

TV, most recently presenting *Planet Ant*. In this issue on p56 he gets out his magnifying glass in search of household critters you can't see.



Tom Heap

The *Countryfile* presenter is one of the UK's foremost environment journalists,

appearing regularly on *Panorama* and the Radio 4 series *Costing The Earth*. Starting on p36, he asks what the future holds for the British summer.



Steve Jones

Prof Jones is a well-known geneticist and science writer whose works are

eagerly awaited in these parts. On p64, we ask Steve to tell us about his new book on Bible-related science and ask: is he serious?



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SUBSCRIBER BONUS

On p32, chemist and renewable energy expert **David Phillips** looks at the latest improvements in solar technology

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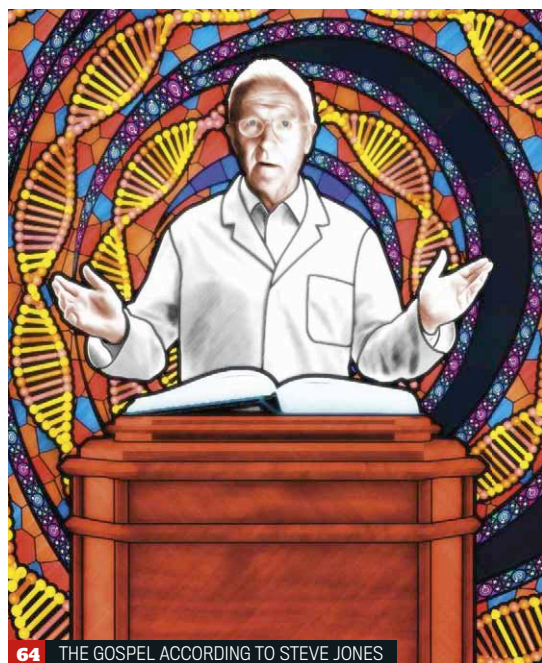
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WHY OUR SUMMERS ARE ABOUT TO GET BETTER





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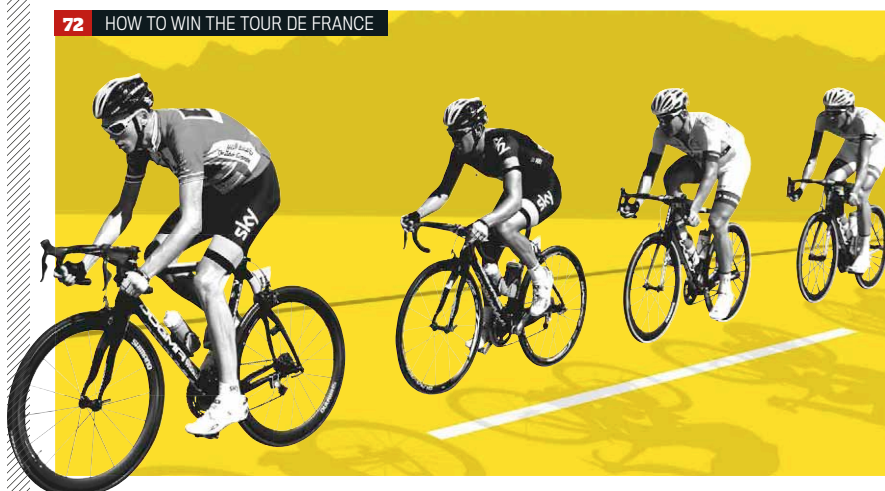
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MegaPixel

Touring telescope

THIS IS NASA'S James Webb Space Telescope, but it will never reach space. That's because this is only a model of the real thing, pictured at the South by Southwest Interactive Festival which took place recently in Austin, Texas.

The model is life-sized, measuring 24m long, 12m wide and 12m tall. The structure is dominated by the telescope's array of hexagonal mirrors and the multilayered sunshield beneath. On the real telescope, the sunshield will protect the mirror and instruments from the heat of the Sun - and the relatively puny amount of heat released by Earth - making it easier for the scope to detect faint infrared light from distant stars and galaxies.

PHOTO: NASA

"The structure that goes into space will mostly be made out of lightweight composite materials, similar to what you find in golf clubs or even car bodies," says Scott Willoughby, James Webb Space Telescope Program Manager at Northrop Grumman, the company that built the model and is leading the telescope's construction. "The model, however, has to survive the Earth's wind and rain, so it's made from aluminium and steel."

The model has been on tour since 2005. You can watch a time-lapse video of it being assembled at bit.ly/15lCnBI

The real thing, costing an eye-watering \$8bn (£5.2bn), is still being built and is pencilled in for a 2018 launch.



For more great pictures, follow us on
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Slaughter in the water

THIS IS RIO de Janeiro's Rodrigo de Freitas lagoon, the venue for rowing competitions in the 2016 Olympics. It required an extensive clean-up in March after tens of thousands of fish died due to low levels of oxygen in the water.

The causes of such piscine carnage, known as 'fish kills', are usually "a combination of factors linked to not only the geography and hydrology [properties and circulation] of the water, but also the meteorological conditions," explains Dr James Ebdon, an expert in water quality at the University of Brighton.

"It is the decomposition of biological material such as

dead algae by bacteria that most commonly leads to oxygen depletion and mass fish kills," Ebdon says. Just before this kill in Brazil, heavy rain washed rotten algae into the lagoon, which is connected to the Atlantic via a canal that splits the Ipanema and Leblon beaches. "Warm, shallow waters, such as those present in the lagoon, have less capacity to carry dissolved oxygen than cooler waters. This means that such fish kills can occur more readily," says Ebdon.

An estimated 65 tonnes of dead yellowtail, catfish, tilapia and sea bass had to be scooped out of the lagoon's waters.

PHOTO: REUTERS







MegaPixel

Crop circles in the desert

IN A STRIP of desert that stretches 2,000km from Angola to South Africa are these strange circles of bare ground surrounded by a ring of plants. Known as 'fairy circles', their origin has baffled scientists for years. But now one ecologist says he has the explanation.

"I started to use long winter nights at home in Germany to fly with Google Earth over the whole sub-continent," says Professor Norbert Jürgens at the University of Hamburg. He found some of the fairy circles to be as large as 50m². "That really attracted me, so I went on the first expedition to Angola in 2006, immediately after the end of the civil war."

Jürgens found that one species is nearly always present within the circles - sand termites. He says they munch away at the roots of grasses, which kills the plants so they aren't around to gulp up the paltry 100mm of rainfall that falls annually. The termites maintain these grass-free patches so they have a moist environment to live in, says Jürgens.

Other ecologists think the termites are innocent, and that the formations are a result of plants competing for resources. Jürgens is convinced he has the right answer, but says: "Many research questions are left, especially as regards the behaviour of the termites and their communication."

PHOTO: NORBERT JUERGENS

REPLY

Your opinions on science, technology and *Focus* magazine



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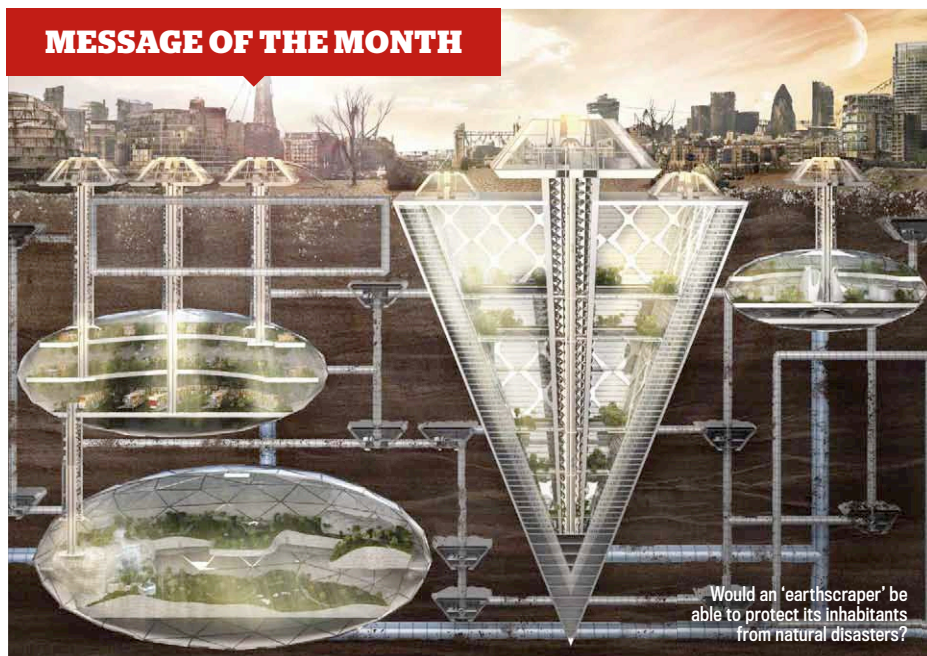
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Letters may be edited for publication

MESSAGE OF THE MONTH



Meat beaters

I really love your magazine and have thoroughly enjoyed reading it for the past 10 years. The June issue's 'Future Of Food' article (p52) was very interesting. However, the part about alternative meats and insect meatballs didn't sit well with me. I didn't like the bit where you listed horses among other animals as alternative meats. The promotion of killing any species for the sake of harvesting flesh to produce food is unnecessary. As a scientific magazine, I would like to see you promote the real alternatives to meat such as the lab-grown meats when they become available. Moreover, giving up meat altogether has been linked to better health and less environmental damage, not to mention less cruelty for animals. I'm not trying to convert anyone to vegetarianism; I simply want to minimise the promotion of meat over other alternatives.

Sara Hamze, Beirut

No insects please

I think that I could eat most of the artificial foods, even insects, as long as it didn't have any visual resemblance to the original. I can't eat shellfish either for that reason – they look disgusting. However, China and Eastern countries have overcome this, probably because of necessity. But I can't, I really would starve first. Food has to look attractive and edible.

Kath Hurman

I'd find insects hard to stomach but if it really came to it, we would eat anything. In the BBC Four documentary Can Eating Insects Save The World?, presenter Stefan Gates met some malnourished boys in southeast Asia and joined them for a meal of fried tarantulas. – Ed

Annoying noises

Good article in the July issue (p50), but I think you should have included the neighbour's lawnmower, which comes out every weekend for three hours. Or how about car horns being blasted to summon someone from their house? Grrrr... By the way, do women react to certain noises

Underground/overground

When reading your article on 'earthscrapers' and subterranean living (p44, July), my initial reaction was that it sounded like a brilliant idea. However, upon further thought, it occurred to me that to be able to live underground, air would have to be channelled through ventilation pipes from the surface. If a natural disaster – for example a hurricane – created enough destruction above ground to even partially block the pipes, wouldn't the people living in the 'earthscrapers' below suffocate?

I am assuming that, as the majority of the 'earthscraper' is below the water table, some degree of tanking would be present in addition to the pumps mentioned in your article. However, should a massive

flooding event occur, would this be enough to prevent another flood within the 'earthscraper'? My primary concern is that evacuation would be near impossible. If you were 300m below the surface, it would take a long time to get to safety. I would feel much safer if I were above ground.

I did not see a mention of using mirrors to transport images from the surface. You said that 'reflective tubes' would be used in 'channelling huge shafts of natural sunlight from above'. Could you not go one step further and create shafts which contain numerous mirrors at 45° angles to bounce the view from above the surface down to a window underground, in the same way that a periscope operates?

Ellie Gleave, Winchester



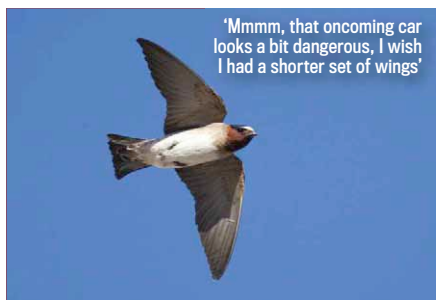
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in and
win!**



The writer of next issue's Message of the Month wins a BubbleScope smartphone accessory worth £49.99. The BubbleScope attaches to an iPhone, Samsung Galaxy or BlackBerry Z10 to take 360° photos and immersive 360° video called 'bubbles'. Visit www.bubblescope.com

more than men? My ex used to accuse me of being obsessive about certain sounds that he claimed not to hear at all!

Ruth Capocci



How swallows evolve

Regarding your piece about cliff swallows evolving shorter wingspans (p26, June), doesn't this sound a lot like Lamarckism instead of evolution? If it's to be the latter, all it really means is that a proportion of long wingspan swallows have been killed off by traffic, leaving the smaller percentage of shorter wingspan swallows an opportunity to breed and grow in numbers. That removes the swallows' personal choice in wing size.

Geoff Willmetts, Bridgewater

Andy Ridgway replies: Swallows don't have any choice in their wing size. A higher proportion of short wingspan birds avoid cars so there are relatively more of them to breed. The researchers themselves point to this being natural selection – see <http://bit.ly/WAXpMO>

Lighter than air?

In Discoveries in the June issue, the story on p28 says "carbon aerogel is lighter even than air." Yet illustrating it is a block of said gel resting upon barley. Surely if it's lighter than air then gel would float like a solid balloon?

Richard Siddall, Southwark

The aerogel material itself is actually less dense than helium, but its pores are filled with air. If you could somehow seal it off from the outside and create a vacuum inside, I believe it would float. – Ed



Wonder materials

Professor Mark Miodownik ('Materials that have shaped our past', p43, July) puts the invention of float glass as being in the 1960s. However, Chance of West Bromwich were selling it much earlier than this. I worked at a small engineering firm where one of the fitters had worked for Chance in the 1940s and had been involved in the development of a process that floated glass on a huge bath of molten tin. Among the problems they had were temperature control of the bath itself and vibration from traffic. They had tight security on the process and I believe they relied on this rather than making use of patents, so patent dates may be later than sales of float glass.

Laurie Penman

Intelligent life

I am prompted to write by the item on p32 of the June issue [Subscriber bonus] concerning intelligent life elsewhere in the Universe. Of course it is assumed that a degree of intelligence is required to provide the technology with which to communicate, but what about the myriad forms of lower life that ultimately resulted in the human race coming into existence? It is interesting to consider how many of the potentially habitable planets might have gone through a similar process as Earth before reaching our present level of intelligence.

Jack Wilson, Hampshire

Oops!

In our June feature 'Black Hole Feeding Frenzy', Sagittarius A* is 245,000 trillion km from Earth, not 254 trillion km.

On p42 of the July issue we mistakenly said the Queen's University Ionic Liquid Laboratory was in Dublin rather than Belfast.

On p80 of the July issue the figures for 'Would you buy a curved TV?' are correct but the pie-chart is wrong.

YOUR COMMENTS ON TWITTER

On twitter.com/sciencefocus we asked **Do brain-training games work?**

@robship You get good at doing the brain-training games; I don't think they help anywhere else in life though.

@Brian_The_Fish No more than crosswords, Sudoku etc

FOCUS

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

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At the heart of the image



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A MATCH MADE IN CYBERSPACE

Is online dating the best route to a lasting relationship? New research says it is

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TESTING TIMES

Would you take a genetic test to see what the future holds?

THE BIG STORY

The first human clone is here

Cloned cells will provide replacement tissues with no rejection risk

HUMAN CLONES HAVE been created for the first time. Far from being fully-developed fetuses, they are balls of just 150 cells. The technique that was used to create the cell balls is being touted as a way to provide replacement tissues for patients who have suffered tissue damage such as a spinal cord injury. But the research remains highly controversial nonetheless.

Dr Shoukhrat Mitalipov at Oregon Health and Science University in the US used a technique similar to the one that produced Dolly the Sheep

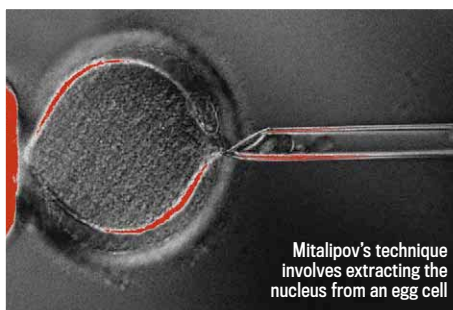


Blastocysts are balls of stem cells that can develop into any other kind of cell

PHOTO: SCIENCE PHOTO LIBRARY



Dr Mitalipov says his research offers new hope for those with hereditary disorders



Mitalipov's technique involves extracting the nucleus from an egg cell



17 years ago to generate the cloned human cells. Adapting it to produce viable human cells has proved problematic until now, but Mitalipov and his team found that a dash of caffeine and a jolt of electricity helped things along.

Mitalipov first fused an adult cell containing DNA with a human egg cell from which the nucleus had been removed, a technique known as 'somatic-cell nuclear transfer' (SCNT). Adding caffeine prevented eggs from being activated too soon, while a jolt of electricity provided the impetus for the embryo to develop into a small ball of cells known as a blastocyst.

The resulting embryonic 'stem cells' can be encouraged to develop into any kind of specialist cell in the body. "Because these reprogrammed cells can be generated with nuclear genetic material from a patient, there is no concern about transplant rejection," explains Mitalipov.

The cloning technique requires donated human eggs and is likely to prompt fears it will lead to the creation of the first fully-

developed cloned human. In recent years, concerns such as this have shifted many stem cell researchers' gaze away from SCNT, towards reprogramming adult cells to take on an embryonic state. These cells become 'induced pluripotent stem cells' (iPSCs). But Mitalipov argues that the cells produced by SCNT are higher quality than iPSCs and, unlike iPSCs, are able to produce all the different types of specialist cell in the body.

Mitalipov says his main goal with this type of research is eradicating diseases carried in the mitochondria – the power plants within cells that, like the nucleus, contain DNA. Here DNA from the nucleus of one egg would be transferred to another egg with healthy mitochondrial DNA and its nucleus removed. The egg would then be fertilised with sperm.

"We are mainly interested in helping families who suffer from a variety of hereditary syndromes due to faults in the mitochondria, such as Leigh syndrome," says Mitalipov. "We are now working on clinical trials for them."

ZOE CORMIER



TIMELINE

A history of cloning advances

1996

Dolly the Sheep, the first cloned mammal, is born. DNA from a skin cell was transferred into an egg stripped of its nucleus, a method called 'somatic-cell nuclear transfer'.

2001

Researchers in Iowa attempt to use SCNT to produce a baby gaur, an Asian ox. But this first clone of an endangered species dies within two days of birth.

2004

Korean researcher Hwang Woo-Suk claims to have cloned human embryos and produced embryonic stem cells. He is exposed as a fraud in 2006 and his papers are all retracted.

2006

A Japanese team succeeds in producing pluripotent stem cells from adult mouse cells, offering an alternative to stem cells derived from embryos. They achieve the same in humans in 2007.

2007

Dr Shoukhrat Mitalipov at the Oregon Health and Science University creates a cloned macaque embryo and successfully extracts stem cells from it. It is the first primate clone.

2011

US researchers produce human embryonic stem cells using somatic cell nuclear transfer. But each cell contains three copies of each gene, rather than the normal two.

2011

The first cloned human embryos are created by Dr Shoukhrat Mitalipov at Oregon Health and Science University, providing a possible new source of replacement tissues.

ANALYSIS

Kerry Bowman



Medical ethicist at the Joint Centre for Bioethics, University of Toronto

“WHETHER OR NOT people object to this kind of research all comes down to what they believe the moral status of a blastocyst is. In some people's eyes, that small clump of cells is already a human life. But I would actually say that for many people – although certainly not all – this doesn't really present a huge ethical problem.

The first and biggest argument against the use of embryonic stem cells is the destruction of embryos. Some will sigh when they read this and say, 'Do we really have to go back down that road? I thought we had left that alone.' I for one am certainly surprised that research into this method of making stem cells is still taking place.

The real question is: does this new research lay down the steps for human cloning? The authors claim it will not, because they have been unable to get the monkey embryos produced with this same method to grow beyond a certain size. Mitalipov says they will publish more research soon explaining why this is.

On human cloning specifically the question is, is that a horrible thing? The biggest ethical argument against it is, in my opinion, the harm that would be brought and the early deaths that would be caused, because we have already seen a lot of the cloned animals that have been created to date suffer deformities and early death.”



WHAT DO YOU THINK?

Should research into cloning human embryos be allowed to continue? Let us know your thoughts at facebook.com/sciencefocus

1 MINUTE EXPERT

Carbon nanotube glucose sensor

What's that?

It's a sensor made from one-atom-thick cylinders of carbon that's able to detect the level of glucose in your saliva. It will offer a pain-free alternative to finger-pricking blood sugar tests for some diabetics.

How does it work?

Carbon nanotubes in the sensor are coated with a liquid called pyrene-1-boronic acid. When glucose binds onto this coating, the electrical current through the nanotubes decreases. By monitoring changes in the current, it's possible to work out how much glucose is present.

What could it be used for?

The sensor would help Type II diabetes sufferers, who do not need insulin injections. They would simply lick a test strip. It's unlikely to be as useful for those with Type I diabetes who need to inject insulin, as glucose levels in saliva lag behind levels in blood, meaning rapid falls in blood sugar could be missed.

When will it be in shops?

The technology's been tested in labs for some time, but researchers at the University of Pennsylvania, USA now think they have a system that's cheap enough to manufacture. It could be available to buy within three to five years.

Tim Peake will head off into space in November 2015

Space exploration

First British astronaut in 20 years will be a high-flying scientist

WHEN TIM PEAKE becomes the first British astronaut in over 20 years to venture into space, he'll be tasked with managing science experiments onboard the International Space Station (ISS).

Peake, an ESA astronaut and British Army Air Corps officer, heard he'd been selected for a six-month stint aboard the 415km-high outpost in a text from his boss at the European Astronaut Centre in Germany. While details of the experiments he'll be involved in have yet to be finalised, there are already hints of what will lie ahead when he lifts off from the Baikonur Cosmodrome in Kazakhstan on 30 November 2015.

"On the ISS we are exploring how the body tolerates microgravity," Peake tells *Focus*. "I'll be joining a Russian and an American who'll be in the last four months of a one-year stay aboard the ISS, so we'll be getting lots of data on how they perform. The body adapts really well to microgravity – the heart muscle shrinks, and blood volume, bone density

and muscle mass all reduce – but it makes returning to Earth's gravity punishing. In the future we could be looking at landing on Mars, with its own gravity, and we'll need to be able to function and perform there."

Peake also says he'd be keen to work on home-grown experiments. "We have the chance to do some voluntary science at weekends," he says. "I'd be delighted if we could inspire our younger generation to come up with some fun science."

The 41-year-old, who was born in Sussex, will now undergo mission-specific training, including learning the intricacies of the science labs on the ISS, learning to operate its robotic arm and brushing up on his Russian.

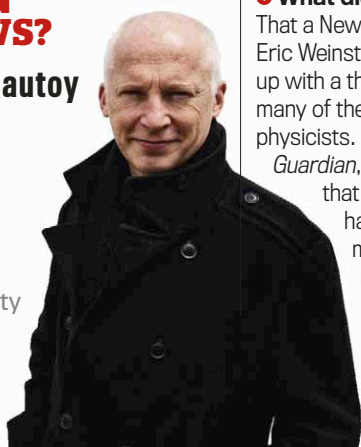
The first Brit in space was chemistry graduate Helen Sharman back in May 1991. Other British-born astronauts such as Michael Foale, Piers Sellers and Nicholas Patrick have flown more recently, but they have either taken Anglo-American citizenship or become full US citizens.

ANDY RIDGWAY

WHO'S IN THE NEWS?

Marcus du Sautoy

BBC science presenter and Professor for the Public Understanding of Science at Oxford University



What did he say?

That a New York economist, Eric Weinstein, may have come up with a theory that answers many of the questions that vex physicists. In an article for *The Guardian*, du Sautoy explains that Weinstein, who has a background in maths and physics, introduced him to his theory two years

ago. "It was an exciting, daring proposal, but mathematically so natural that one could not but feel that it smelled right."

So what is the new theory?

Weinstein's Geometric Unity theory proposes a 14-dimensional 'observer' that contains our four-dimensional space-time continuum within it. It's being touted as a 'Theory of

Everything' – one that links all known physical phenomena.

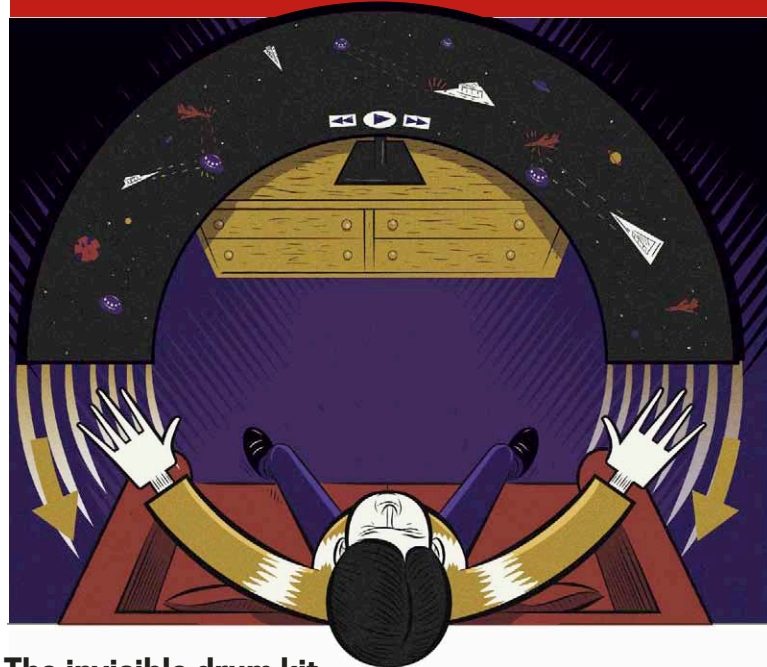
What reaction has the theory prompted?

While du Sautoy is enthusiastic, some physicists are being more circumspect. They would like to see specific predictions from Weinstein about how the Universe works that could be tested with experiments.



PATENTLY OBVIOUS

Inventions and discoveries that will change the world with James Lloyd



TV that bends at your whim

EARLIER THIS YEAR, LG Electronics launched the first curved OLED television – the idea being that the curve eliminates visual distortion at the edges of the screen. Now it looks like the next development will be a TV that bends exactly where you want it to at your command, providing you with the perfect viewing angle wherever you are in the room.

Samsung's flexible display has a 'panel deformation member' attached to its rear

surface – essentially a material that applies a force to the screen to bend it. This could be a bimetal, for example – two metals joined together. When the two metals are heated, they expand by different amounts, causing the screen to bend.

Couch potatoes will be able to use a remote control to change the direction and amount of bending without getting up, and then adjust the image so it's not distorted.

Patent application number: US 20130114193

The invisible drum kit

EVER DREAMED OF being the next Dave Grohl but don't have enough space for a drum kit? Then you might be interested in an invisible drum kit that's been crafted by a duo of inventors.

Richard Lee in Ireland and Yann Morvan in Wiltshire, England have designed an instrument that uses motion capture technology to generate sounds as the drummer mimes playing a beat. A digital camera captures the movement of reflective markers attached to the tips of drumsticks and the

drummer's feet. The musician's gestures are analysed by a computer, which triggers drum and cymbal sounds depending on the position of the markers. The more frantic the movements, the louder the drumming sound.

The designers say the technology provides drummers with the same level of musical expression as physical drums without the need for bulky and cumbersome equipment.

Patent application number: GB 2496521



Smartphones get light protection

BLACKBERRY HAS INVENTED a way to stop others snooping into your private text messages. The smartphone owner wears an infrared light transmitter, perhaps built into some earrings or a pair of glasses, and when its light is detected by the phone the screen shows its contents as usual. But when the owner looks away, the drop-off in light causes the screen to dim or switch off.

Patent application number: US 20130094866



Greg Valentine, the ping-pong ball's nemesis



THEY DID WHAT?!

Meadow full of ping-pong balls blown up

What did they do?

A team of volcanologists in the USA set off explosives they had buried in a meadow in Ashford,

New York along with tennis balls and ping-pong balls.

What happened next?

The blasts sent sand, gravel and the balls flying 80m into the air, leaving behind craters up to 2m wide. The volcanologists, led by Dr Greg Valentine from the University at Buffalo in New York used high-speed cameras, seismometers and infrasound

microphones to record the effects of their handiwork.

Why did they do this?

These controlled explosions will help the researchers understand what happens when several eruptions take place in the same crater – a common phenomenon. The results suggest that repeated blasts from the same crater limit how far rocks will fly.

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GRAPHIC SCIENCE

Seeing research differently

Online dating is key to a happy marriage

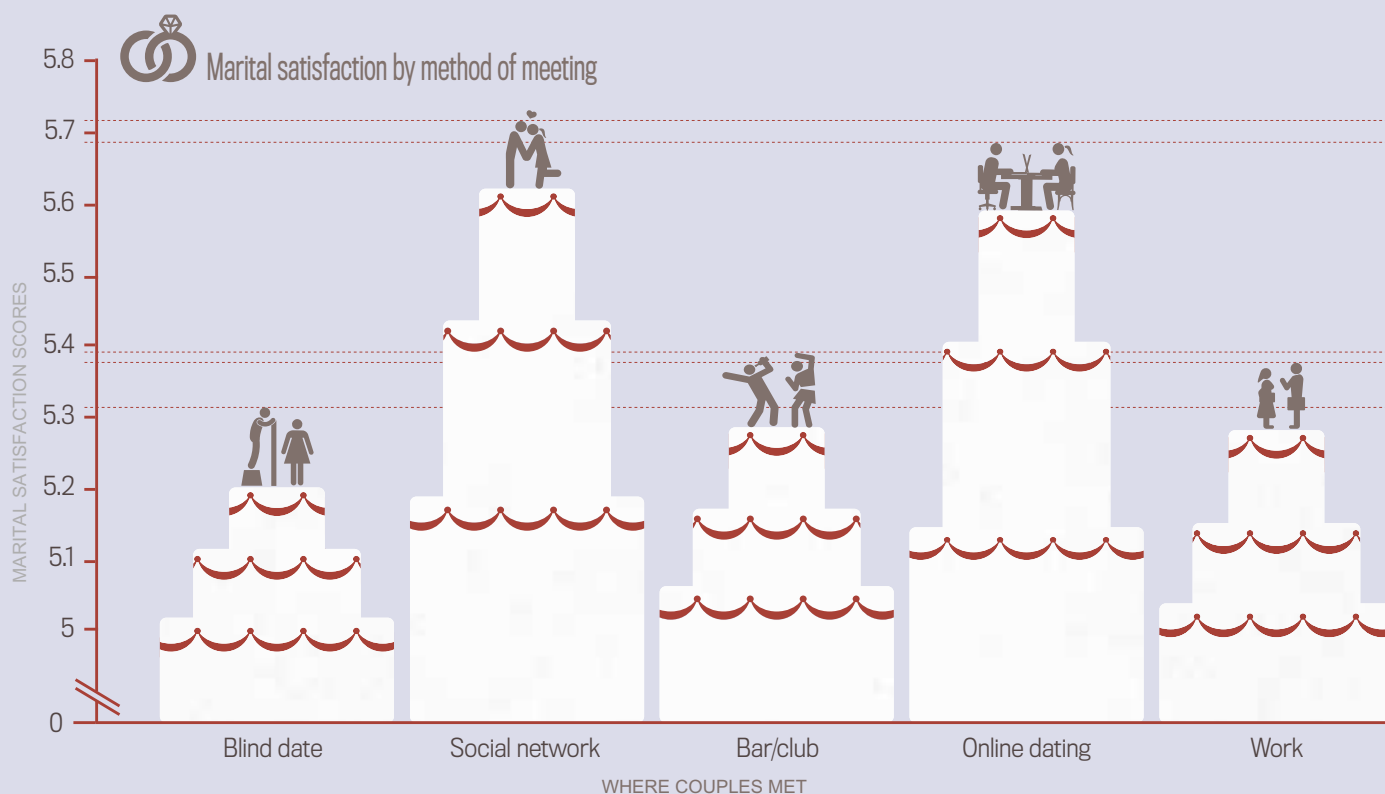
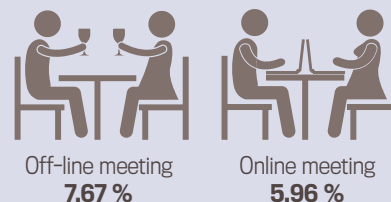
MORE PEOPLE ARE meeting their future spouses online these days. In fact, one-third of marriages in the US now begin with a digital rather than a face-to-face meeting. So what difference is this making to our marital happiness?

To find out, researchers at the University of Chicago and Harvard University surveyed just over 19,000 married – or previously married – people to assess how blissful their marriages

were. They were asked questions like 'How satisfied are you with your marriage?', to which the answer was a score from 1 to 7. They were also asked to score statements such as 'we have chemistry'. The overall 'marital satisfaction' score was calculated from all these answers.

The results showed that couples who meet online are less likely to break up and are also more satisfied with their life partners.

PERCENTAGE OF MARITAL BREAK-UP



NEWS IN BRIEF

Mammoth cloning hope

• The discovery of a woolly mammoth carcass, with its muscle tissue preserved and liquid blood, has sparked a flurry of reports that a cloned animal is now almost inevitable. The remains of the female were recovered from Russia's Novosibirsk Islands by Professor Semyon Grigoriev of North-Eastern Federal University, Siberia, Russia.



Tsunami warnings by GPS

• GPS technology could have provided a warning of the 2011 Japanese tsunami three minutes after the earthquake that caused it, according to German research centre GFZ. The uplift of the seafloor triggered by an earthquake also deforms coastal regions, something GPS could spot. The 2011 tsunami hit Japan's northeast coast less than half an hour after the earthquake.

Mars trip is cancer risk

• A return trip to Mars would expose astronauts to dangerous radiation levels, new data shows. A detector that flew to the Red Planet along with the Curiosity rover showed a crew would receive 0.662 sieverts of radiation. NASA sets a lifetime radiation risk for female astronauts at 0.6–1 sieverts and 0.8–1.2 for men.

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HOT TOPIC



Angelina Jolie faced the kind of tough decision a great many of us may soon have to make



WHAT DO YOU THINK?

Let us know your opinions at twitter.com/sciencefocus using the hashtag #hottopic, and on facebook.com/sciencefocus



Zac Taylor: Yes! I suddenly became ill six years ago from a genetic illness I'd never even heard of before. If I had known there was a good chance I would get it years earlier, I would've been much more prepared for the trauma.



Rob Buck: After getting to know some doctors who can tell so much about my health just by my posture, fingernails etc, I'm thinking I might as well know it all.



Ross Kobak: Foresight would allow you to make changes to minimise your chances of contracting a possible illness or disease. But if you knew a person was at higher risk of developing an illness or disease 15 years down the road, would you be as willing to employ them, treat them or offer them insurance?



Sadie: No. I was offered a test but if the test was positive then I had to inform my insurance holder.

Would you have a test to find out what your genes have in store for you?

ANGELINA JOLIE'S announcement that she had a double mastectomy to minimise her chance of developing breast cancer illustrates the decisions many of us will face in future – whether to have a genetic test, and what to do if it shows up something negative.

Like one in every 1,000 people, Jolie has a faulty copy of the gene BRCA1. Women with it have a 60 to 90 per cent chance of developing breast cancer, and a 40 to 60 per cent chance of ovarian cancer. BRCA1 is involved in repairing DNA damage: if the gene is faulty, an inability to repair mutations can lead to cells multiplying uncontrolled, forming tumours.

"We are still actively finding many other genes that play a role in breast cancer, though most of them don't carry as high a risk as the BRCA1 and BRCA2 genes," says Professor Doug Easton of the University of Cambridge, a geneticist whose work is funded by Cancer Research UK.

"In future, it's likely that testing will be widened to include a broader range of genetic changes," he says. "Ideally, we could target those [patients] with genetic risks with preventative drugs."

Wider-ranging genetic tests are imminent. From 2014, women treated for breast and ovarian cancer at London's Royal Marsden hospital will be offered a

test for 97 genes that increase cancer risk. The tests will be used to select drugs and decide how much tissue around a cancer to remove. Those found to have genes linked to a particular cancer are likely to have more tissue removed as a precaution.

But the decision whether or not to have other genetic tests is not so clear-cut. Huntington's disease is a case in point. It's an incurable condition whose progress cannot be slowed down, and the suicide rate among early test subjects resulted in a requirement for psychological evaluation beforehand.

ZOE CORMIER

NEWS IN BRIEF

Depression scrambles biological clock

• The activity levels of a set of genes in the brain change in a distinct pattern throughout the day, US researchers have found. But in depressed people, the genes' pattern of activity is not the same. The finding could lead to new treatments for depression.

Genes in depressed minds follow different patterns of activity



Reactions caught on camera for first time

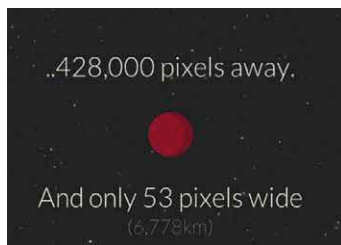
• Researchers in the US and Spain have captured 'before and after' images of a chemical reaction that show the structure of molecules and the bonds between atoms. To do this, the team chilled the molecules to -270°C and viewed them using an atomic force microscope.

Win friends with pheromones

• A pheromone in male sweat makes other men more cooperative. At Finland's University of Turku, volunteers were asked to share 10 Euros. Those who took a hefty whiff of androstadienone offered more than those who hadn't.

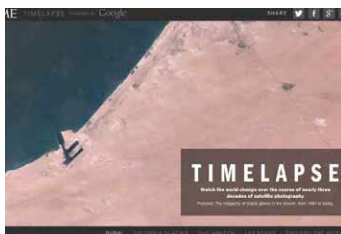
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New websites, blogs and podcasts



You may think it's a long way down the road to the takeaway, but that's just peanuts to space

is, by whizzing you on that journey through a Solar System that's measured in pixels, not kilometres. You're likely to be surprised just how long it takes.



See Las Vegas sprawling across the desert, or watch the Amazon rainforest slowly vanishing

seamless animations. Watch Dubai expanding into the sea, and glaciers retreating before your eyes.



Science Studio brings together the best science-related videos, soundclips and animations

Lego, and listen to an acoustic tribute to the Space Shuttle. Then cast your vote for this year's best multimedia science on the web.

World Wide Web

The World Wide Web (WWW) is a wide-area [hypermedia](http://www.first-webside.web.cern.ch) information retrieval system using a given network access to sources of documents.

Everything there is online about WWW is linked directly or indirectly to the document, including an [exhaustive summary](http://www.first-webside.web.cern.ch) of projects, [Mailing lists](http://www.first-webside.web.cern.ch), [FAQs](http://www.first-webside.web.cern.ch), [Newsletters](http://www.first-webside.web.cern.ch), [Weblogs](http://www.first-webside.web.cern.ch), [Podcasts](http://www.first-webside.web.cern.ch), [RSS feeds](http://www.first-webside.web.cern.ch), [E-books](http://www.first-webside.web.cern.ch), [Audio](http://www.first-webside.web.cern.ch), [Video](http://www.first-webside.web.cern.ch), [Images](http://www.first-webside.web.cern.ch), [Animations](http://www.first-webside.web.cern.ch), [Games](http://www.first-webside.web.cern.ch), [Applications](http://www.first-webside.web.cern.ch), [Tools](http://www.first-webside.web.cern.ch), [Utilities](http://www.first-webside.web.cern.ch), [Services](http://www.first-webside.web.cern.ch), 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Genetics

Tiny 'alien' is human after all – but questions remain

SINCE IT WAS found in Chile's Atacama Desert, a tiny skeleton has been the subject of internet speculation that it might be a visitor from another planet. But genetic analysis now reveals the figure is actually human – although the analysis so far carried out on the 15cm-long body with its dome-shaped head doesn't explain why it has the skeletal characteristics of a young child.

'Ata' was found buried near a church in the ghost town of La Noria. A crowd-funded documentary called *Sirius* features the results of DNA tests by Stanford University geneticist Prof Garry Nolan, which confirm that Ata is human. In fact the figure's mitochondrial DNA reveals, perhaps unsurprisingly, that its mother was from Chile. A separate X-ray analysis by pediatric radiologist Dr Ralph Lachman at the Cedars-Sinai Medical Center in Los Angeles showed that the epiphyseal plates of the knees – growth plates at the

end of long bones, found only in children – are the same as those in 6-8-year-olds.

This means that tiny Ata either suffered extreme dwarfism and lived until this age, or – more likely – had a rapid ageing condition and died in the womb or shortly after birth. So far, Nolan has not found any genes that might have caused such defects, leading him to believe that if the cause was genetic, an as-yet-unknown gene or set of genes was responsible.

Nolan says the media frenzy surrounding Ata neglects the human tragedy. "At first, I thought the sample might simply be a monkey," he says. "When it became clear it was likely human, I realised we had a child. I will continue research on the specimen, along with what I have now learned might be similar specimens, to determine if there is a common genetic lesion.

Hopefully we can understand the cause, and benefit women who might be at risk of similar birth defects."

HAYLEY BIRCH



DOOMWATCH with Bill McGuire

The world's biggest natural disasters in waiting



HEKLA VOLCANO

Where: Southern Iceland

HARD ON THE heels of the Eyjafjallajökull eruption that brought air travel chaos in 2010, and 2011's less disruptive Grímsvötn blast, another Icelandic volcano might be waking up. An increase in earthquake activity at Hekla since March, accompanied by swelling of the ground, suggests magma may be on the rise. More than 20 Hekla eruptions have been recorded since the Middle Ages,

some big enough to leave ash layers in Scottish peat bogs. Now, the civil authorities have raised Hekla's alert level from green to yellow (the third highest). With the volcano erupting roughly every 10 years since 1970, and the latest blast 13 years ago, it'll be no surprise if Hekla goes bang soon.



LAKE SAREZ

Where: Gorno-Badakhshan province, Tajikistan

IN EASTERN TAJIKISTAN in Central Asia, a vast body of freshwater with a volume of about 16km³ lies behind a debris dam 3km above sea level. The lake has accumulated since an earthquake in 1911 triggered a landslide and blocked the Murghab River. Two earthquakes in April, one of magnitude 4.7, have led to worries that a bigger quake could break the

dam or trigger a landslide into the lake, generating a tsunami. After blasting through narrow, densely populated valleys, a resulting flood could still be two storeys high when it reached Termiz (population 140,000) on the border of Uzbekistan and Afghanistan – 1,400km downstream of Sarez.



PACIFIC TYPHOONS

Where: China, Japan, Taiwan, Philippines

UNLIKE THE NORTH Atlantic, the northwest Pacific is under threat from tropical storms all year round, with massive storms known as typhoons pounding the coasts of China and Japan every year and cutting swathes of destruction across Taiwan and the Philippines. This year looks like being particularly lively, with storm watchers

Tropical Storm Risk (www.tropicalstormrisk.com) forecasting 26 storms. Of these, 16 are expected to reach typhoon strength, which means an average wind speed above 120km/h. Nine of these are likely to be super-typhoons, driving average winds of 150–200km/h, with the potential to cause enormous destruction should they make landfall.



BILL MCGUIRE is Professor of Geophysical & Climate Hazards at University College London and the author of *Waking The Giant*

FOCUS READER SURVEY

WIN
an iPad mini!



HAVE YOUR SAY

Dear Reader,

I hope you're enjoying this issue of *Focus*, which contains our usual, diverse mix of fascinating science, new technology and great pictures. Now I'm asking for your help to find out if there's anything we can improve. Simply send in the survey (photocopies accepted) by 27 July and you'll be entered in a draw to win an Apple iPad mini worth £269. Postage is free, or you can enter online at www.sciencefocus.com/survey

Thanks for your time!

Graham Southorn, Editor



A. READING/BUYING

1. How often do you buy *Focus*?

- Always – I am a subscriber ☐ 1
Always – Every issue, but don't subscribe ☐ 2
Quite often – Once in every two/three issues ☐ 3
Occasionally ☐ 4
This is my first issue ☐ 5

2. On average, how long do you spend reading an issue of *Focus*?

- Under 30 mins ☐ 1
30 mins – 1 hour ☐ 2
1 – 2 hours ☐ 3
2 – 3 hours ☐ 4
3 – 6 hours ☐ 5
Over 6 hours ☐ 6

3. How many other people have read or looked at any of your copies of *Focus* for longer than 2 minutes in the last 12 months?

- One ☐ 1 Six ☐ 6
Two ☐ 2 Seven ☐ 7
Three ☐ 3 Eight ☐ 8
Four ☐ 4 Over eight ☐ 9
Five ☐ 5 Nobody else ☐ 0

B. YOUR INTERESTS

4. Do you ever visit science festivals?

- Yes, regularly ☐ 1
Yes, occasionally ☐ 2
No ☐ 3

5. Which of the following science festivals have you visited?

- Brighton ☐ 1 Glasgow ☐ 9
Bristol ☐ 2 London ☐ 0
British Science Festival ☐ 3 Manchester ☐ 1
Cambridge ☐ 4 Orkney ☐ 2
Cheltenham ☐ 5 Oxfordshire ☐ 3
Dundee ☐ 6 Wrexham ☐ 4
Durham ☐ 7 Other (please specify) ☐ 5
Edinburgh ☐ 8

6. How interested are you in each of the following subjects?

- | | Very
1 | Quite
2 | Not very
3 | Not at all
4 |
|------------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Adventure | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Alternative energy | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Archaeology | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Astronomy/Astrophysics | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Biology | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Chemistry | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Computing | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Cosmology | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Early humans | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Egyptology | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Engineering | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Environment | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Futurology | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Gadgets | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Genetics | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Geology | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Maths | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Medicine/Health | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Natural disasters | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Neuroscience (brain science) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Palaeontology | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Physics | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Psychology | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Space exploration | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Sports science | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Technology | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

7. Do you visit any of the following websites?

- Tick all that apply
- | | Regularly
(at least once a week)
1 | Occasionally
2 |
|--------------------------------|--|--------------------------|
| BBC Science & Environment News | <input type="checkbox"/> | <input type="checkbox"/> |
| Discovermagazine.com | <input type="checkbox"/> | <input type="checkbox"/> |
| Discovery News | <input type="checkbox"/> | <input type="checkbox"/> |
| Engadget | <input type="checkbox"/> | <input type="checkbox"/> |
| Gizmodo | <input type="checkbox"/> | <input type="checkbox"/> |
| Howitworksdaily.com | <input type="checkbox"/> | <input type="checkbox"/> |
| Howstuffworks | <input type="checkbox"/> | <input type="checkbox"/> |
| io9.com | <input type="checkbox"/> | <input type="checkbox"/> |
| LiveScience | <input type="checkbox"/> | <input type="checkbox"/> |
| Nationalgeographic.com | <input type="checkbox"/> | <input type="checkbox"/> |
| Nature | <input type="checkbox"/> | <input type="checkbox"/> |
| New Scientist | <input type="checkbox"/> | <input type="checkbox"/> |
| Popular Science | <input type="checkbox"/> | <input type="checkbox"/> |
| ScienceDaily | <input type="checkbox"/> | <input type="checkbox"/> |
| Stuff.TV | <input type="checkbox"/> | <input type="checkbox"/> |
| T3.com | <input type="checkbox"/> | <input type="checkbox"/> |
| Wired.com | <input type="checkbox"/> | <input type="checkbox"/> |
| Other | <input type="checkbox"/> | <input type="checkbox"/> |

8. Which social networks do you use?

- Tick all that apply
- | | Regularly
(at least once a week)
1 | Occasionally
2 |
|-----------|--|--------------------------|
| Bebo | <input type="checkbox"/> | <input type="checkbox"/> |
| Facebook | <input type="checkbox"/> | <input type="checkbox"/> |
| Google+ | <input type="checkbox"/> | <input type="checkbox"/> |
| MySpace | <input type="checkbox"/> | <input type="checkbox"/> |
| Pinterest | <input type="checkbox"/> | <input type="checkbox"/> |
| Reddit | <input type="checkbox"/> | <input type="checkbox"/> |
| Twitter | <input type="checkbox"/> | <input type="checkbox"/> |

C. ABOUT FOCUS MAGAZINE

9. What is your main reason for buying *Focus*?

Rank 1-4 in order of importance with 1 being most important

- To gain knowledge
For entertainment
As a teaching tool
For work

10. Has reading *Focus* ever resulted in you:

- Tick all that apply
- | Attending an event/exhibition | <input type="checkbox"/> 1 |
|--|----------------------------|
| Buying a game | <input type="checkbox"/> 2 |
| Buying a recommended book | <input type="checkbox"/> 3 |
| Buying another product advertised/reviewed | <input type="checkbox"/> 4 |
| Contacting an advertiser | <input type="checkbox"/> 5 |
| Downloading an app | <input type="checkbox"/> 6 |
| Going online for information about a product | <input type="checkbox"/> 7 |
| Going online to research an article further | <input type="checkbox"/> 8 |
| Telling someone about a product advertised | <input type="checkbox"/> 9 |
| Visiting the magazine's website | <input type="checkbox"/> 0 |
| Watching a TV programme | <input type="checkbox"/> X |

11. Do you use the star charts printed in *Focus* to observe the night sky?

- Often – at least once a month ☐ 1
Sometimes – every 2-3 months or less ☐ 2
Never ☐ 3

12. Do you think the level of articles in *Focus* is:

- | Much too academic | <input type="checkbox"/> 1 |
|---------------------|----------------------------|
| Bit too academic | <input type="checkbox"/> 2 |
| About right | <input type="checkbox"/> 3 |
| Bit too simplistic | <input type="checkbox"/> 4 |
| Much too simplistic | <input type="checkbox"/> 5 |

13. How much did you enjoy this issue of *Focus*?

- Very much ☐ 1
Quite a lot ☐ 2
Not very much ☐ 3
Not at all ☐ 4

14. Listed below, in page order, are the articles appearing in this issue of *Focus*. For each item please tick the column which comes closest to your opinion.

- | Pg. no. | Article | Did you read
1 | Very interesting
2 | Quite interesting
3 | Not very interesting
4 | Not at all interesting
5 |
|---------|--|--------------------------|--------------------------|--------------------------|---------------------------|-----------------------------|
| 6 | MegaPixel | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 12 | Reply | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 15 | Discoveries | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 27 | Robert Matthews column | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 29 | Helen Czerski column | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 35 | Summer Q&A special | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 56 | Meet The Lodgers | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 64 | The Gospel according to Steve Jones | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 70 | Journey to the stars | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 72 | Tour de France science | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 79 | Tech Hub: BBC surround video | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 81 | Bill Thompson column | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 82 | Tech Hub: Garmin sat-nav | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 83 | Appliances of science | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 85 | Compact cameras vs smartphones | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 88 | How do we know... meaning of Egyptian hieroglyphs? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 95 | To Do list: pick of the month | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 96 | To Do list: visit | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 98 | To Do list: watch (TV) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 100 | To Do list: listen/touch/play | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 102 | To Do list: read | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 111 | Mindgames: puzzles | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 112 | Mindgames: crossword | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 114 | Stephen Baxter column | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

15. What would you like to see more or less of in *Focus*?

- | | Would like more
1 | About right
2 | Would like less
3 |
|--------------------------------------|--------------------------|--------------------------|--------------------------|
| Apps (To Do List) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Book reviews (To Do List) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Columnists | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Feature articles | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Gadgets (Tech Hub) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Games (To Do List) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| History of science (How Do We Know?) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| MegaPixel photos | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Puzzles (Mindgames) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Q&A | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Reader letters (Reply) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Science events (To Do List) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Science news (Discoveries) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| What's on TV & radio (To Do List) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

16. *Focus* costs £3.99. What do you think of this in terms of value for money?

- Very good value ☐ 1
Good value ☐ 2
Average value ☐ 3
Poor value ☐ 4

17. Are you reading *Focus* more or less frequently than last year?

- More regularly ☐ 1
Less frequently ☐ 2
About the same ☐ 3

READER SURVEY

FOCUS

18. If you are reading *Focus* less frequently please tell us why.

.....

D. www.sciencefocus.com

19. How often do you visit the *Focus* website – www.sciencefocus.com?

- Never ☐ 1
 Only visited it once ☐ 2
 Once every couple of months ☐ 3
 Once a month ☐ 4
 2-3 times a month ☐ 5
 Once a week ☐ 6
 A few times a week ☐ 7
 Daily ☐ 8
 More than once a day ☐ 9

20. How often do you access each of the following parts of www.sciencefocus.com?

	Regularly	Occasionally	Never
Carousel (picture menu at top of page)	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3
Features	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Focus TV	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Forum	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Galleries	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Latest from <i>Focus</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Magazine	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
News	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q&A	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Quiz	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Reviews	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Subscribe	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Win	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

E. About our digital presence

21. Do you follow *Focus* on Facebook?

- Yes ☐ 1
 No ☐ 2

22. Do you follow @sciencefocus on Twitter?

- Yes ☐ 1
 No ☐ 2

23. How often do you listen to the *Focus* podcast?

- Every fortnight ☐ 1
 Once a month ☐ 2
 Less often ☐ 3

24. What do you want to hear on the podcast?

Rank 1-5 in order of importance with 1 being most important

- Interviews with experts
 News reports
 On-location reports
 Science questions answered (Q&A)
 Studio discussion
 Vox pops with the public

25. Do you currently buy or subscribe to any digital versions of *Focus* for tablet, smartphone etc?

- I have a digital subscription ☐ 1
 Don't have a digital subscription but regularly buy/download a digital copy ☐ 2
 Don't have a digital subscription but occasionally buy/download a digital copy ☐ 3
 Have never bought a digital copy of *Focus* ☐ 4

26. How likely are you to read the digital edition of *Focus* in the future?

- Very likely ☐ 1
 Quite likely ☐ 2
 Not very likely ☐ 3
 Not at all likely ☐ 4
 No opinion ☐ 5

27. If you were to buy any digital version of the magazine, on what sort of device would you be likely to read it?

- Please tick all that apply
 Desktop computer ☐ 1
 E-reader (Kindle, Nook, Kobo) ☐ 2
 Laptop computer ☐ 3
 Mini tablet (Kindle Fire, Nexus 7, iPad mini) ☐ 4
 Smartphone ☐ 5
 Standard size tablet/iPad ☐ 6

F. About you

28. Are you...

- Male ☐ 1
 Female ☐ 2

29. Are you...

- Married/living with partner ☐ 1
 Single ☐ 2
 Divorced/separated ☐ 3
 Widowed ☐ 4

30. Which age group are you in?

- Under 18 ☐ 1
 18-25 ☐ 2
 26-35 ☐ 3
 36-45 ☐ 4
 46-55 ☐ 5
 56-65 ☐ 6
 66-75 ☐ 7
 Over 75 ☐ 8

31. What is your current working status?

- Employed full-time ☐ 1
 Employed part-time ☐ 2
 Studying full-time ☐ 3
 Studying part-time ☐ 4
 Retired ☐ 5
 Not working ☐ 6

32. If you are in employment, what type of industry/ profession do you work in?

- Civil Service ☐ 1
 Engineering ☐ 2
 Financial ☐ 3
 IT ☐ 4
 Law ☐ 5

Local government

- Medicine ☐ 6
 Research ☐ 7
 Retail ☐ 8
 Science/Tech ☐ 9
 Teaching ☐ 0
 Other ☐ x
 Other ☐ v

33. What is your highest educational level overall?

34. What is your highest educational level in science?

	Overall	Science
O level/GCSE	<input type="checkbox"/> 1	<input type="checkbox"/> 1
A level or similar	<input type="checkbox"/> 2	<input type="checkbox"/> 2
BTEC	<input type="checkbox"/> 3	<input type="checkbox"/> 3
HNC/HND	<input type="checkbox"/> 4	<input type="checkbox"/> 4
Degree	<input type="checkbox"/> 5	<input type="checkbox"/> 5
Higher degree	<input type="checkbox"/> 6	<input type="checkbox"/> 6

35. If you are teaching science/technology, please indicate the highest level you teach:

- Primary school ☐ 1
 Secondary school, pre GCSE ☐ 2
 GCSE ☐ 3
 A Level or similar ☐ 4
 Degree ☐ 5
 Further degree ☐ 6
 Adult education/leisure learning ☐ 7

36. What is your total/combined household income?

- Under £20,000 ☐ 1
 £20,000-£29,999 ☐ 2
 £30,000-£39,999 ☐ 3
 £40,000-£49,999 ☐ 4
 £50,000-£59,999 ☐ 5
 £70,000-£99,999 ☐ 6
 £100,000-£149,999 ☐ 7
 £150,000+ ☐ 8
 Rather not say ☐ 9

37. Is your home

- Mortgaged ☐ 1
 Owned outright ☐ 2
 Rented ☐ 3
 Other ☐ 4

38. Would you be willing to take part in future research for *Focus*?

- Yes ☐ 1
 No ☐ 2

THANK YOU FOR HELPING

Thank you for taking the time to complete this questionnaire. If you wish to be included in our free prize draw please remember to fill in your name, address and telephone number clearly in the space provided below. Please return your questionnaire by 27 July 2013 to the address below.

Focus magazine Reader Survey
 FREEPOST ANG20499, PO Box 33
 Woodbridge
 IP12 4BR

Immediate Media Company (Publishers of *Focus*) would love to keep you informed by post or telephone of special offers and promotions from the Immediate Media Company Group. Please tick if you'd prefer not to receive these ☐

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INSIDE SCIENCE

ROBERT MATTHEWS

WHEN TRYING TO jazz up reports of esoteric research, it's hard to resist metaphors. I'm as guilty as anyone. Whenever I'm writing about the search for the so-called Theory of Everything, the formula describing all the particles and forces in the cosmos, I find myself typing words like 'quest' and 'the Holy Grail of physics'. But then my formative years were spent in the Golden Age of the Metaphor, when American 'superheroes' took on adversaries from 'behind the Iron Curtain' to win the 'Space Race'.

By the time that race was won, another metaphor was making headlines worldwide, and is still doing so 40 years on: the War on Cancer. The term was coined by then-US President Richard Nixon, at a time when the world was plagued by wars that were anything but metaphorical: the Vietnam War, the Yom Kippur War, the Cold War. All those wars ended decades ago, but the War on Cancer rumbles on, its lab-coated foot soldiers popping up every so often to claim a battle won here or a bridgehead established there.

Behind closed doors, though, many cancer scientists will tell you the idea of total victory is ludicrous. Not that you'd

twig this from the current advertising campaigns of some cancer charities. They're still banging on about how we can 'beat' this disease that affects 1 in 3 people during their lifetime, and kills half of them within five years.

On the face of it, they've got the stats to back their case. Cancer survival rates in the UK have doubled since 'war' was declared, and treatment of some forms of the disease have seen genuinely dramatic improvements. Cancer charities often cite testicular cancer and childhood leukaemia as examples of how the billions they've poured into research have paid dividends. It's true that neither disease is the death sentence it used to be, thanks to the discovery of wonder drugs to treat them. But these triumphs weren't the result of Nobel-winning insights into how cancer works; they were completely accidental. The first came from studies of a plant extract thought to treat diabetes, the second from research into the effect of electricity on microbes.

Should we stop giving money to cancer charities? Of course not. While victory remains elusive, researchers have won some major battles, from identifying cancer-related genes to reducing drug side-effects. But talking up these advances reminds me of the spin military

"In the war against cancer some of the generals are starting to speak out about the need for a new strategy"



Some scientists believe keeping cancer in check may be a better strategy than trying to eliminate it completely

leaders put on wars they know they can't win. Fortunately, in the war against cancer some of the generals are starting to speak out about the need for a new strategy. One of the most outspoken is Dr Robert Gatenby of the Moffitt Cancer Center in Florida, who thinks that victory against cancer should be replaced with containment.

It's a strategy that's working with some other implacable foes. There is still no cure for AIDS, yet since the mid-90s death rates have been cut by up to 80 per cent by Highly Active Anti-Retroviral Therapy (HAART), in which HIV, the virus that causes AIDS, is held in check by several drugs simultaneously. The incurable genetic disorder cystic fibrosis has seen similarly impressive results, again from research aimed at containing its effects rather than defeating it.

Would a similar strategy work with cancer? There are already some positive signs. It's long been known that the all-guns-blazing approach to cancer therapy often kills off all but the most aggressive cancer cells, which then come surging back with deadly speed. Researchers have reported that some cancers can be kept in check by occasional warning shots of therapy, rather than being blitzed.

Many scientists – and the charities that fund them – will doubtless balk at such 'appeasement'. But after 40 years of failing to achieve a 'victory' over this most resourceful of enemies, it must surely be worth trying a different strategy. And a new metaphor to go with it. ■

ROBERT MATTHEWS is Visiting Reader in Science at Aston University, Birmingham

THE NEW PEUGEOT RCZ CAPTURE THE THRILL



NEW PEUGEOT RCZ FROM £21,595 OTR*

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*Model shown is an RCZ GT THP 156 with pearlescent paint, matt black roof arches and vision pack at £25,645. Prices quoted are on the road and include delivery to dealership, number plates, 12 months' government vehicle duty and £55 first registration fee. Information correct at time of going to print. Visit peugeot.co.uk for full terms and conditions.

NEW PEUGEOT RCZ

MOTION & EMOTION



PEUGEOT



HIDDEN TREASURES

HELEN CZERSKI

SUMMER HAS ARRIVED, along with – hopefully – beautiful bright days. At which point we'll complain that it's just too hot. But there is one place where it's not too hot: the place that keeps the ice cream, lettuce and yogurt cold. Fridges and freezers are amazing, but why should that amazingness be limited to one small box in the corner? Why can't we open the door and share the chill with the rest of the kitchen?

We might think that fridges just sit there and hum, but they're actually engaged in a tremendous battle. A fridge goes against the grain of the Universe. What should be happening is that heat flows from hotter things to colder things. Hot drinks warm you up, and your warm hands can melt ice cubes by giving them heat. It's all one way. We call this the second law of thermodynamics, one of the most fundamental things we know about our Universe. So how does a fridge buck the trend?

The hum of a fridge is caused by a compressor squeezing a special gas, a refrigerant, to get it to a high pressure. Then the pressurised gas is squirted into sealed pipes inside the fridge. It's a bit like squirting an aerosol can: the gas suddenly expands, and so it cools down. Next time you squirt an aerosol, touch the can afterwards. It'll be cool for the same reason. So the food in the fridge gives some of its heat to the cool fluid, and the food cools down. Magic!

Except there's a price to pay. Have you ever wondered why a fridge needs a power supply? Surely you're taking energy away from the food so that it cools down; why do you need other energy to do that? This is because your fridge is doing a deal with the Universe, and the currency of that deal is entropy. Entropy is a measure of disorder in the Universe and, as anyone looking at the washing up will know, things tend to get more disordered if left to themselves.

Order in your fridge is about separation. Inside the fridge we have cold air; outside there is warm air. That's fairly ordered. As soon as you open the door, the warm and cold air molecules will mix

and become more disordered. This is the second law of thermodynamics at work: it says entropy must always increase, even though there's the same amount of energy overall.

The deal is this: inside the fridge, it gets colder and entropy decreases. But to pay for that, the outside must get hotter, and even more entropy must be generated in the rest of the kitchen. To make the inside colder, you need the extra energy from the power supply, and in the end all that extra energy becomes heat at the back of the fridge. More heat is put out into the

“Almost every home in Britain has a machine for defying the Universe - even if it only works on the inside of one box”



Thermodynamic rebellion: keeping ice creams cool defies the Universe

kitchen than is taken from the inside of the fridge. The fridge can win the battle inside its small box, but it will always lose the war.

So the rules of the Universe say that opening the fridge door can't cool down the kitchen, because the tiny bit of coolness inside the fridge must be outweighed by the extra heat and entropy on the outside. Opening the fridge door will actually heat up the kitchen, because the Universe and the second law must always win overall.

Next time you have a cold drink, think about the price paid for that coolness. I find it fascinating that almost every home in Britain

has a machine for defying the Universe – even if it only works on the inside of one box. An ice cream isn't just a tasty treat, it's a minor act of thermodynamic rebellion. ■

DR HELEN CZERSKI is a physicist, oceanographer and BBC science presenter whose shows include *Operation Iceberg* and *Orbit*



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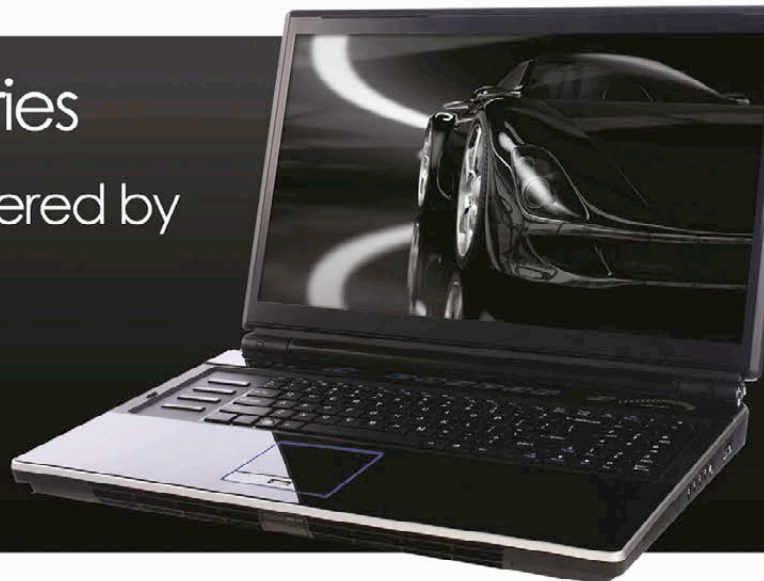
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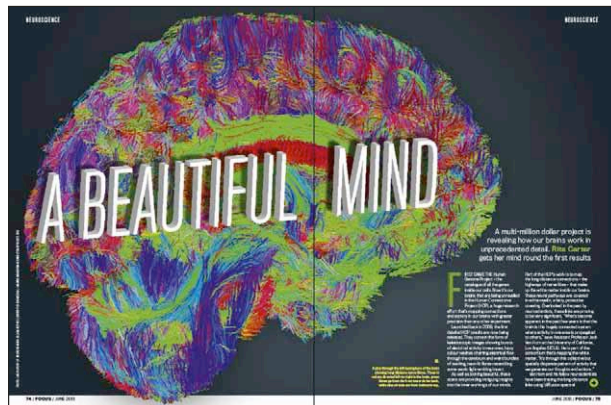
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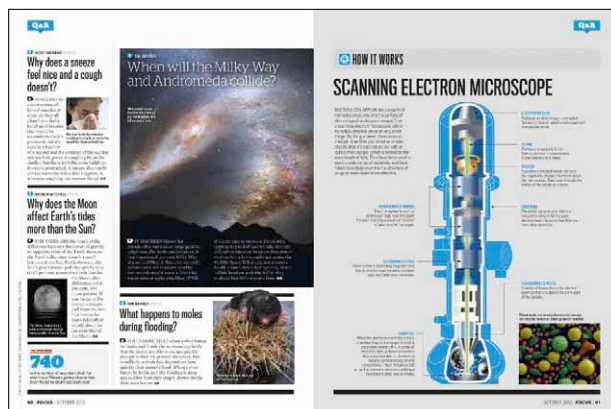
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SUMMER SPECIAL

Q&A

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Are our summers about to get better?

Scientists are closing in on why barbecues are being cut short by torrential downpours and whether the future will be drier



Tom Heap is a presenter on *Countryfile* on BBC One and *Costing The Earth* on Radio 4

LAST SUMMER I met an ice-cream maker in Yorkshire. A combination of location and profession suggesting rightly that he's an optimist. But after several years of gloomy summers, even his sunny mood was darkening. Five out of the last six summers have given us below average hours of sunshine and 2012 was the second wettest year since records began.

So are poor summers here to stay for a while, or are they a blip we've passed through? Dr Tim Woollings, a meteorologist at the Walker Institute for Climate System Research at the University of Reading, says the immediate future isn't looking too bright: the next few summers will be "similar to our last ones", he says.

WHAT'S TO BLAME?

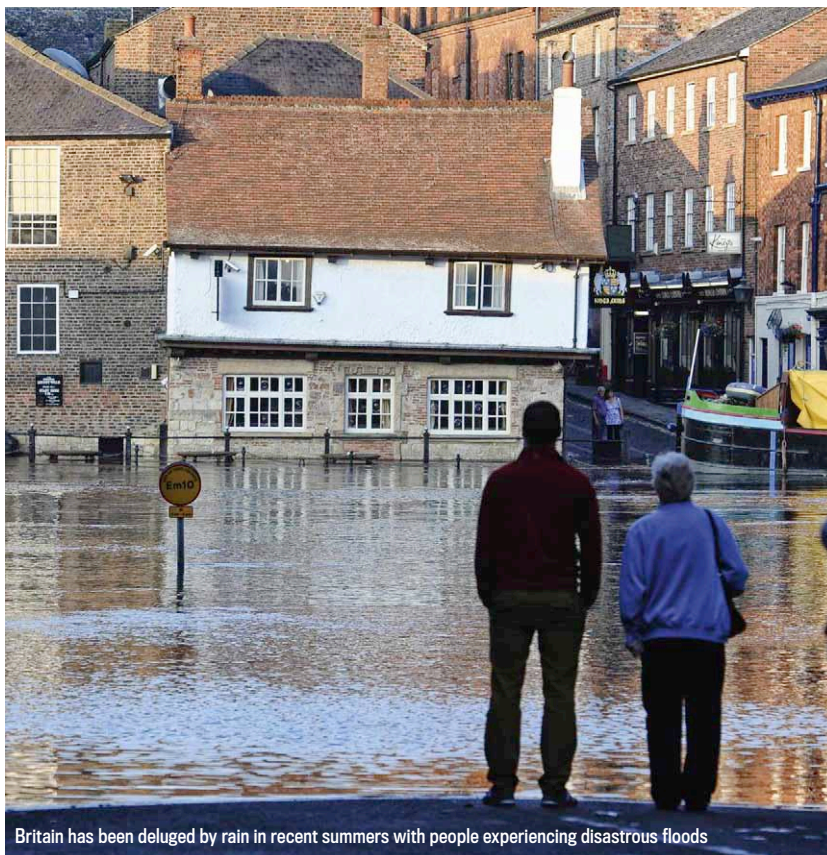
It's long been known that the jet stream – a fast-flowing river of air in the upper atmosphere – acts like a flexible fence dividing the weather in western Europe. When it flows to the north of us, we bask in the Sun. When it swings to the south, we're left in the cold.

What decides the jet stream's route is the focus of intense research. But Woollings says the key factor is the temperature gradient between the tropics and the pole – a big difference shifting the jet stream further north. Unfortunately for us in Britain, the North Atlantic Ocean surface has been relatively warm – up to 1°C above average – heating the air above it and flattening the temperature gradient. This has drawn the jet stream further south, leaving us exposed to bad weather.

It's not the first time a warmer North Atlantic has wreaked havoc with our summers. Dr Adam Scaife, Head of Seasonal to Decadal Prediction at the Met Office, says wet summers in the 1880s and 1950s coincided with unusually warm North Atlantic water.

So what's behind this rise in water temperature? Historical records suggest that the North Atlantic's temperature varies naturally over decades and is itself affected by the changing strength of the Gulf Stream, the powerful current that transports warm water from the Caribbean to the North Atlantic.

Does this mean that we are now stuck with mud-caked music festivals every summer? Scaife thinks we



Britain has been deluged by rain in recent summers with people experiencing disastrous floods

are close to the peak of the Gulf Stream's power and if it weakens, the North Atlantic will cool and barbecue summers will make a welcome return. But there is a big 'but' – climate change.

WET, WET, WET

Our planet is warming, but this does not mean Britain gets hotter every year. Indeed there is no strong correlation between a toasty year globally and our own temperature peaks. But climate change is having a profound and consistent effect on Arctic sea ice. Since 1979, satellites have provided a record of its scale and according to NASA's Earth Observatory, in that time the average amount of ice remaining at the

In Numbers

70

per cent of the normal amount of summer rainfall fell in Kinlochewe in the Northwest Highlands of Scotland in 2012. While the rest of Britain was soaked, the Highlands and Hebrides were sunny and dry.

end of summer has shrunk by 11 per cent per decade. September 2012 saw the smallest patch of frozen north ever recorded.

This removes the white ice shield from the water, leaving it exposed to being heated by the rays of the Sun and potentially enhancing the strong Gulf Stream's warming. Scaife also says that the reduced reflectivity of the North Pole could be leading to a greater chance of low-pressure systems dominating British Summer, while stressing this is a tentative conclusion from ongoing research. "The mechanism is still being researched, but may involve changes to the surrounding oceans," he says.

It's a complicated picture, but it means that paradoxically, for the next decade or so, climate change might tilt us towards cool and wet weather.

FUTURE FORECASTS

Gaze further into the crystal ball and the forecast changes again. Towards the middle and end of the 21st Century, our fortune teller is United Kingdom Climate Projections (UKCP) – a joint Met Office and UK government guide to the future British climate. The guide carries varying projections for our weather depending on the amount of greenhouse gas, principally carbon dioxide, we produce. If we take their medium emissions scenario, the most probable outcome for the British Isles is a 2-3°C rise in the summer temperatures by the 2050s and a 3-4°C



“Paradoxically, for the next decade or so, climate change might tilt us towards cool and wet weather”

In Numbers

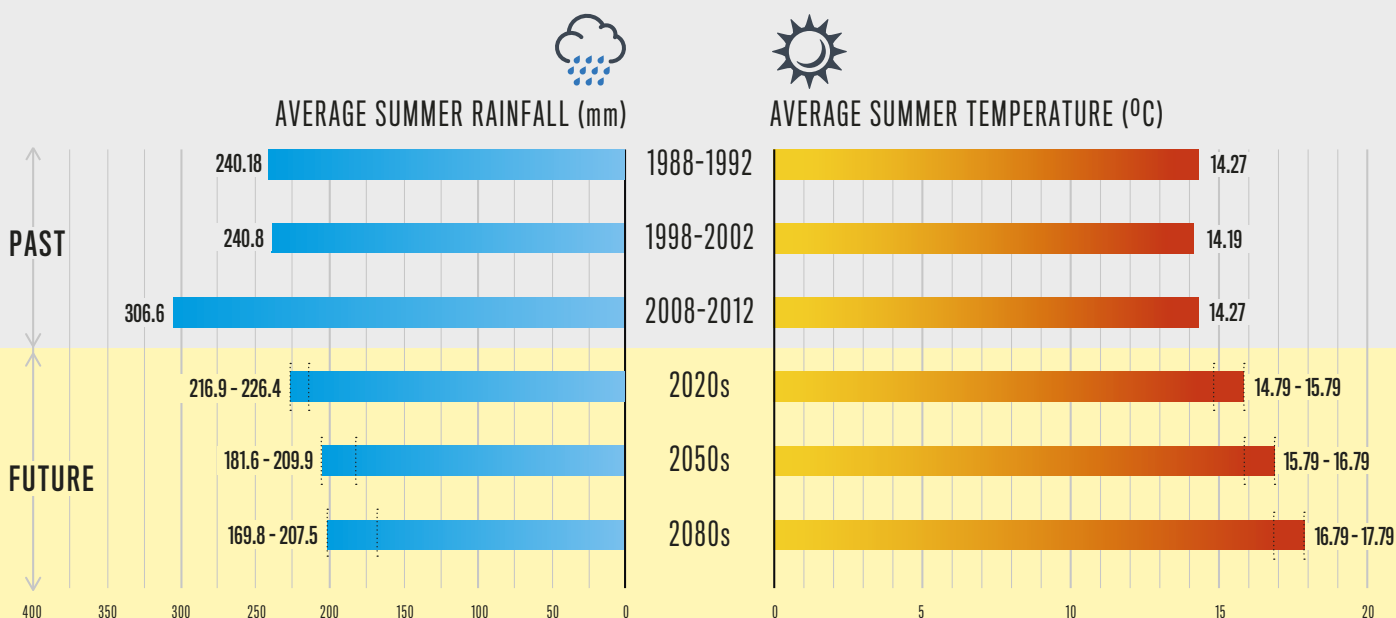
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centimetres of rain fell in just one day in Martinstown, Dorset, on 19 July, 1955. It is Britain's wettest day on record.



The summers they are a-changin'

How Britain's temperatures and rainfall will evolve in the future



Figures for previous averages taken from Met Office figures. Future figures are from United Kingdom Climate Projections (UKCP).

SUMMER IN THE 2050s

You'll need to stock up on sun cream in the future...

OUR BEST INSIGHT into what our summer weather will be like in the future is UK Climate Projections (UKCP09). Produced by the Met Office, the database shows how hot and wet it will get as greenhouse gas levels rise. Climate scientists used the latest in climate modelling techniques to put the figures together, publishing their findings in June 2009. UKCP09 provides high and low predictions as well as 'central estimates', which are shown on the map (right).

The results are clear. By the 2050s, Britain's summers will be hotter and drier than they are now. Last year was an unusually wet summer, with an average of 350mm rain across England. The Met Office says that by the 2050s, London will have just 35 per cent of that level of rainfall over the summer months.

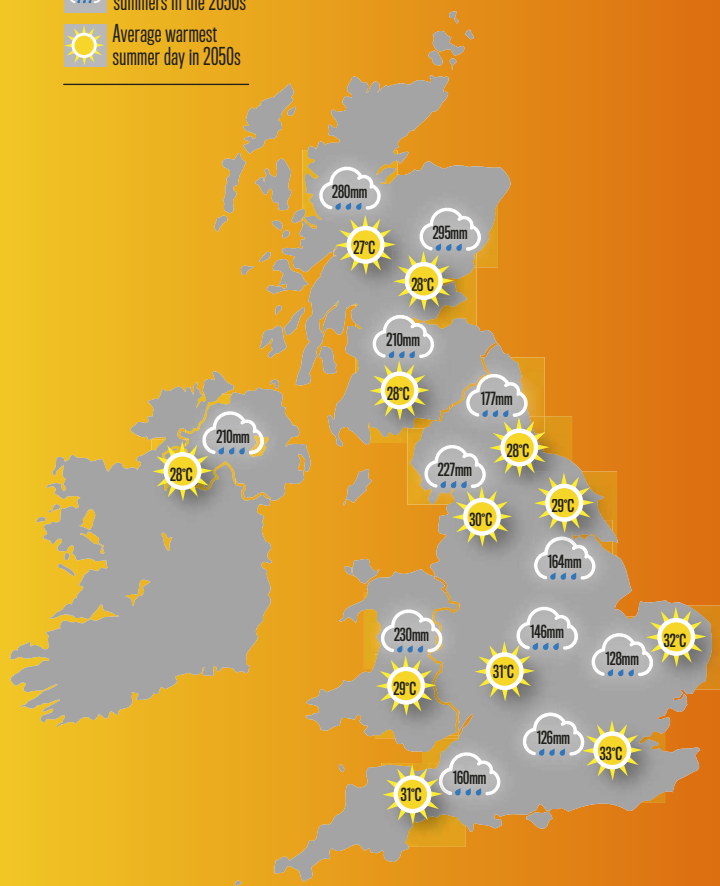
To take a look at a more detailed picture of the future weather in your region, visit:
www.metoffice.gov.uk/climatechange/guide/ukcp/map



Could we see a return to the droughts that struck England in 2006?

KEY:

- Estimated rainfall for summers in the 2050s
- Average warmest summer day in 2050s



Future figures are from United Kingdom Climate Projections (UKCP). Summer is given as the period from June to August

"The best models and meteorological minds say summers will get hotter and drier as the century progresses"

➔ rise by the 2080s. Summer rainfall decreases by around 17 per cent by mid-2050 and 20 per cent by 2080.

So while the short to medium term prognosis is one of cooler, wetter British summers, the best models and meteorological minds say they will get hotter and drier as the century progresses.

But the past few years of erratic summer weather demonstrate the complexities of climate modelling – they require constant modification based on the

most recent weather patterns. Models can still prove insightful, says Scaife. He compares climate change to a slightly biased roulette: "Each yearly spin of the wheel looks random and can throw up unexpected numbers, but over time a pattern emerges. With climate change, we are tilted towards the warm."

WILD TIMES

But Britain won't simply be warmer and drier. The greenhouse effect, which is at the root of climate change, means we are trapping more heat in the atmosphere. Warming seas will lead to greater evaporation and therefore more water in the atmosphere. This, combined with the larger amounts of pent up energy in the system, will mean more extremes – droughts, storms, gales, torrential rain and floods.

A country once considered to be blessed with a benign, equable climate, we've now become rather wary of our weather. Chances are we'll become even more wary in the future. ■

In Numbers

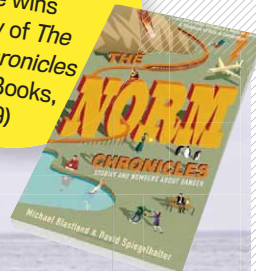
2,183

more people than normal died in Britain during the August of 2003. The higher death rate is attributed to a heat wave.

QUESTION OF THE MONTH

WINNER!

Sue wins
a copy of *The
Norm Chronicles*
(Profile Books,
£12.99)



Some people just
have to show off,
don't they?

Q SUE WATKINS, ANDOVER

What's the best way to build a sandcastle?

A AMAZINGLY, SCIENTISTS have only recently got to grips with this – despite the importance of understanding the behaviour of sand and similar 'granular' materials in civil engineering.

As every kid who's played on a beach knows, dry sand refuses to form anything but a pathetic cone-shaped heap, while wet sand just slumps. Clearly there must be an optimum water content, and last year, researchers at the University of Amsterdam showed that this is around just 1 per cent. That's enough to ensure the water

molecules bridge the gaps between the sand grains, gluing them together by capillary attraction.

They're amazingly effective at doing so, too. The team found that by using the optimum amount of water they could create a vertical column of sand that was 2.5m (8ft 2in) tall yet only 40cm (15in) in diameter before it collapsed. Formed into a traditional sandcastle shape with sloping sides, the tower could be even taller.

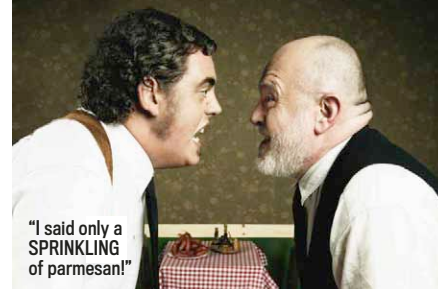
So, the best way to build a sandcastle is to add just a dash of water to your sand mix. **RM**

Q MIKE BEESON, LONDON

Are people who live in hot places more hot-headed?

A IN GENERAL, YES. Various studies have shown that violent crime rates rise in warm weather – up to a point. In the US, crime rates rise as temperature increases up to around 26°C, but start to fall again at around 32°C. Hot weather makes us more stressed, which raises adrenalin levels and reduces our ability to think rationally. We also spend more time outdoors when it's hot and so interact more with others generally.

If you plot global homicide rates on a map, you'll find that the most violent countries do tend to cluster toward the equator (Russia is a notable exception), but this has a lot to do with deprivation in tropical countries as well. **LV**



Q RICH, TWITTER

Why do we tan in summer sun but not winter sun?

A AT TEMPERATE LATITUDES, the Sun is much lower in the sky in winter. This means that it strikes the ground at an oblique angle and the intensity of the rays is distributed over a wider area; plus, light takes a longer path through the atmosphere, so more is absorbed by the air and pollution. We also spend most of our time indoors. But it is still possible to tan and even burn in the winter: just go skiing. Long hours outdoors at high altitudes, in clear mountain air with lots of white snow to reflect the rays, will tan your face just as effectively as a sunbathing session at the beach. **LV**

TOP TEN

MOST PAINFUL INSECT STINGS

(rated by entomologist Justin Schmidt)

Schmidt says the most painful sting is "like walking over flaming charcoal with a rusty nail in your heel".



1. Bullet ant

Schmidt pain rating: 4+
Location: Rainforests from central America to Paraguay
Length of insect: 2.25cm



2. Tarantula hawk

Schmidt pain rating: 4.0
Location: India, SE Asia, Australia, Africa, Americas
Length of insect: 5cm



3. Warrior wasp

Schmidt pain rating: 4.0
Location: Indonesian island of Sulawesi
Length of insect: 4cm



4. Paper wasp

Schmidt pain rating: 3.0
Location: 1,100 different species worldwide
Length of insect: 2.2-2.5cm



5. Red harvester ant

Schmidt pain rating: 3.0
Location: Southwestern United States
Length of insect: 0.5-0.7cm



6. Large velvet ant

Schmidt pain rating: 3.0
Location: 5,000 species, mainly in the tropics
Length of insect: Up to 1.5cm



7. Tropical social wasp

Schmidt pain rating: 2.5
Location: Brazil, Argentina
Length of insect: 1-3cm



8. Large tropical carpenter bee

Schmidt pain rating: 2.5
Location: Southeast Asia
Length of insect: 3.5cm



9. Honeybee

Schmidt pain rating: 2.0
Location: Seven different species worldwide
Length of insect: 1.2-1.6cm



10. Bald-faced hornet

Schmidt pain rating: 2.0
Location: North America
Length of insect: 1.7cm

Q ROBERT TYNES, LONDON

Why is the sound of the sea relaxing?

A THERE IS NO doubt that sea sounds can be soothing. Indeed a whole industry of therapeutic recordings depends on it. But there is no accepted explanation. One clue is that the sea can sound much like white noise; that is, a mixture of all frequencies. White noise is known to be relaxing, possibly because it drowns out disturbing noises or even occupies enough of the brain's activity to push away unwanted thoughts. Repetitious sounds, like waves crashing rhythmically on a pebble beach, can also be

relaxing. This may be because we adapt, or habituate to them – yet other repetitive watery sounds, such as a tap dripping, can be infuriating because we cannot block them out, and the reason for this difference is not clear.

Another possibility is that we associate sea sounds with happy memories of sunny holidays on the beach. Finally, evolutionary psychologists suggest that our ancestors evolved close to water and depended on it to survive. So it is natural to feel safe listening to the sound of the sea. **SB**

Fortunately she was washed ashore with deck chair, a good book and a cooler full of beer



Q MATT EAVES, CAMBRIDGE

Do animals get hayfever?

A WE ARE ANIMALS and some of us get it, so the answer is yes. But if you mean other species, then some do show allergic reactions to grass and tree pollen. Most animals have no problems. After all, they have evolved and lived their lives along with pollen-producing plants. The worst cases are pet dogs and cats, who may have lost their natural immunity through selective breeding or through being kept mostly indoors in pollen-free air and then let outside. Some symptoms are similar to those of

humans, including itching skin and ears, and watery eyes. Even herds of domestic cattle have been known to show signs of pollen allergy. **SB**

Bonzo decided to give the Chelsea Flower Show a miss this year

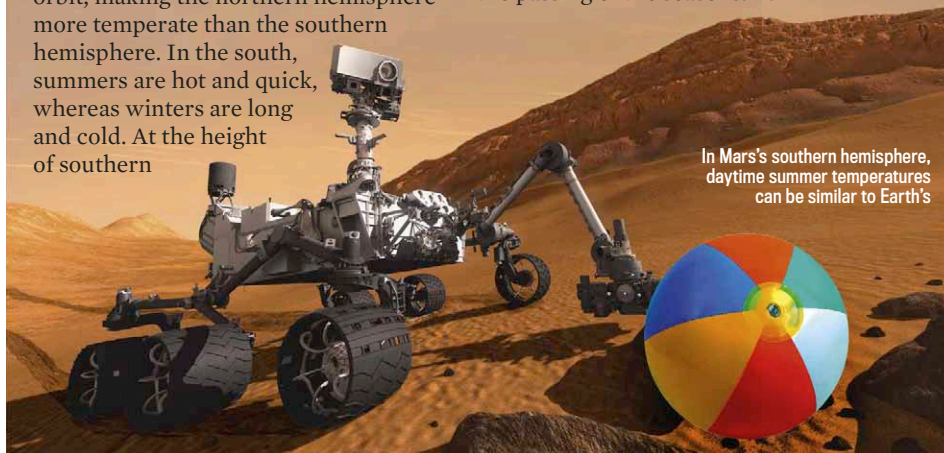


Q TOM REES, LEAMINGTON

What's summer like on Mars?

A MARS'S SPIN AXIS is tilted by 25.2°, very similar to Earth's. Mars therefore has seasons much like our own, although since its year lasts about 687 days, seasons on Mars last almost twice as long. Martian seasons are complicated by the planet's elliptical orbit, making the northern hemisphere more temperate than the southern hemisphere. In the south, summers are hot and quick, whereas winters are long and cold. At the height of southern

summer, temperatures can reach 20°C (68°F) by day but drop to -80°C (-112°F) at night. Even so, there is little 'weather' on Mars. Apart from the varying sizes of the polar ice caps, more common dust storms in late summer and the changing temperature, there is little to indicate the passing of the seasons. **AG**



WHAT IS THIS?



KNOW THE ANSWER?

Go to sciencefocus.com/qanda/what and submit your answer now!

LAST MONTH'S ANSWER:

An opal mining area in Coober Pedy, South Australia - well done Alex Mason.

Q SIMON LEIGH, LUTTERWORTH

How much can a human sweat?

A DURING EXERCISE, MOST of us will sweat no more than 1.4 litres per hour. The highest sweat rate recorded by an athlete was 3.7 litres per hour by the marathon runner Alberto Salazar in 1984. But unless you drink to replenish lost fluid and electrolytes, you will suffer seizure and heart failure once you have lost around 25 percent of your bodyweight in sweat. That's about 17.5 litres for a 70kg adult - but you'd be in no shape to run quite a while before that. **LV**

Sweating excessively can kill you in the long run... but it would have to be a very long run



? Did you know?

The first planet found to orbit two stars, like Luke Skywalker's home of Tatooine in *Star Wars*, is Kepler-16b.



Q AMELIA CHAMBERS, OXFORD

Can you get sunburnt through glass?

A SUNBURN IS CAUSED by the UVB radiation in sunlight. That's the wavelength range from 280 to 315 nanometres. Most window glass will block at least 90 per cent of the rays in this range. That's equivalent to SPF10 sunscreen, except that it doesn't rub off and you can't 'miss a bit'. Sunbathing behind glass doesn't block the UVA wavelengths (315 to 400nm) nearly so well though. This is a mixed blessing because while it means that you can still tan behind glass, it also means your skin is suffering the ageing effects of sun exposure, such as wrinkles and sagging. **LV**



'Damn - I just bought this ultra-modern glass-clad house and now *Focus* tells me I'll get wrinkles indoors'

Q MARY CROFT, LONDON

What will happen if my computer overheats?

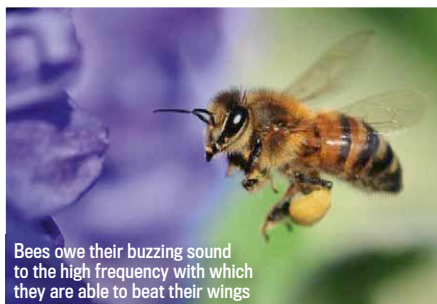
A THE PROCESSORS IN your PC are a finely honed system where electrons pass through tiny gates of silicon. Excessive heat overexcites the electrons, causing them to move too energetically. Your computer will give more errors and start running slowly. It will then start crashing and be reluctant to boot up. Once the chips are truly frazzled, it will die altogether. **GM**



Q SAM ELTON, PRESTON

Why do bees buzz?

A BEES AND OTHER *Neoptera* insects don't flap their wings directly. Instead, the flight muscles pull on the springy thorax wall to make it 'ping' in and out. Bees also have muscles that can contract multiple times from a single nerve impulse. Together these adaptations allow bees to beat their wings at 200-230Hz (cycles per second). We hear this as a buzzing tone. Bees also buzz when not flying, to shake pollen from a flower onto their body. **LV**



Bees owe their buzzing sound to the high frequency with which they are able to beat their wings

Q KATRINA O'BRIEN, EXETER

Is love more likely to bloom in hot weather?

A IT MAY FLOURISH when the Sun shines. In a recent French experiment, five 20-year-old men set out to ask for women's phone numbers, approaching those walking alone in the street who appeared to be aged 18-25. When the Sun was shining, 22 per cent of the women gave out their phone numbers, compared with 14 per cent on cloudy days. Bright sunshine lowers levels of melatonin (the sleep hormone) and increases levels of serotonin in the brain, leading to a better mood. So probably both the men and women felt more cheerful and more inclined to take a chance. The temperature was about the same on the different days so it was likely the sun, not the heat, that did the trick. **SB**



Wait for the clouds to clear before trying your luck

Q DANIEL CROWBY, DURHAM

How do solar thermal power plants work?



When complete, Ivanpah will be the world's biggest solar thermal power station

A THE IDEA BEHIND solar thermal power is very simple: use mirrors to bounce the Sun's heat onto a water-filled boiler, and direct the resulting steam over turbines to produce electricity. It's clean, green and far more efficient than solar cells, turning around 35 to 50 per cent of solar energy into electricity, compared to just 15 per cent for solar cells. It's also relatively easy to store the collected energy: the heat collected during daylight is used to melt sodium and potassium-based compounds which then slowly release the heat as they re-solidify.

It all sounds impressive, but there are some major technical challenges. First, the Sun's heat is pretty dilute, so a solar thermal power station has to cover a huge area. The world's largest, being built near Ivanpah, California, sprawls across 15km² of desert, yet will meet barely 0.1 per cent of the state's power needs. The mirrors must also track the Sun to make the most of its energy, pushing up costs (in the case of Ivanpah, to over \$2 billion). With solar cells getting ever cheaper, there are now serious doubts about the economic viability of this technology. **RM**

Will holiday flights get shorter in the future?



Graham Warwick is the managing editor of technology for Aviation Week

EUROPE TO AUSTRALIA in less than five hours? Not for decades yet – but by 2050, perhaps. As remote as this possibility seems, it took a step closer on 1 May 2013 when a small unmanned aircraft launched from a carrier plane over the Pacific and flew for three minutes at five times the speed of sound, powered by a new kind of engine.

Boeing's missile-sized X-51A WaveRider is a long way from a globe-spanning airliner. But its supersonic-combustion ramjet engine, or 'scramjet', is crucial to hypersonics – flight at speeds above Mach 5.

Unlike a rocket, the scramjet burns conventional fuel in atmospheric air. This avoids the need to carry liquid oxygen in cryogenic tanks and allows it to use normal runways, opening up the possibility of routine passenger flights at speeds that would dramatically shrink the globe.

The turbine engines used on today's passenger jets will not work at such high speeds – air entering the engine would overheat and melt the blades. But the secret to a scramjet is getting fuel to burn when air stays in the combustion chamber for only a fraction of a second, and getting that to happen is proving problematic.

There are other complications too. At hypersonic velocities, aerodynamics and thermodynamics – how

the intense heat generated by friction affects the aircraft – become inextricably linked and the aircraft's structure becomes an integral part of its propulsion system.

Research on scramjets has been under way for decades, but the total amount of air-breathing flight at hypersonic speed can be counted in minutes. That is far from enough to understand all the challenges.

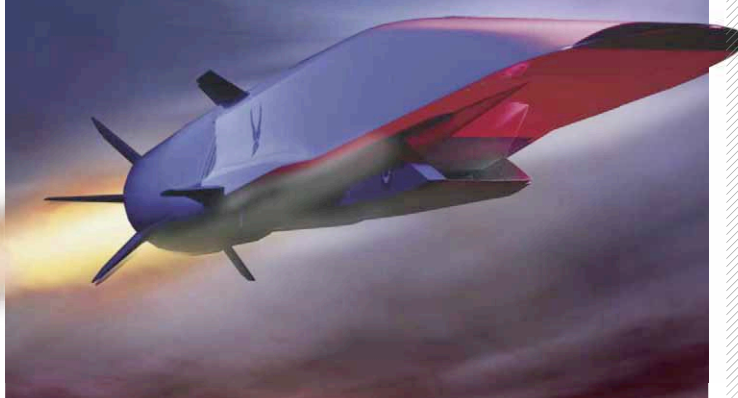
But we've no need to wait until 2050 or beyond for scramjet technology to come of age – the technology already exists to build a supersonic airliner that could fly from Europe to Australia in half the time it takes right now. Such an aircraft would

use turbofans: similar to those in today's fighter engines, but more durable. It could fly as soon as 2030. NASA is working on this with Boeing, Lockheed Martin and Gulfstream as well as Rolls-Royce. It's this kind of technology that we're likely to see on short-haul flights – scramjets would only be practical over longer distances.

Technology aside, economics is the key factor that determines how quickly our aircraft will fly in the future. It means that in the short term, passenger aircraft could actually get slower, as manufacturers strive to save fuel by reducing drag.

GRAHAM WARWICK

Would you want to sit in something like this? If it means swapping Slough for Bondi in five hours...



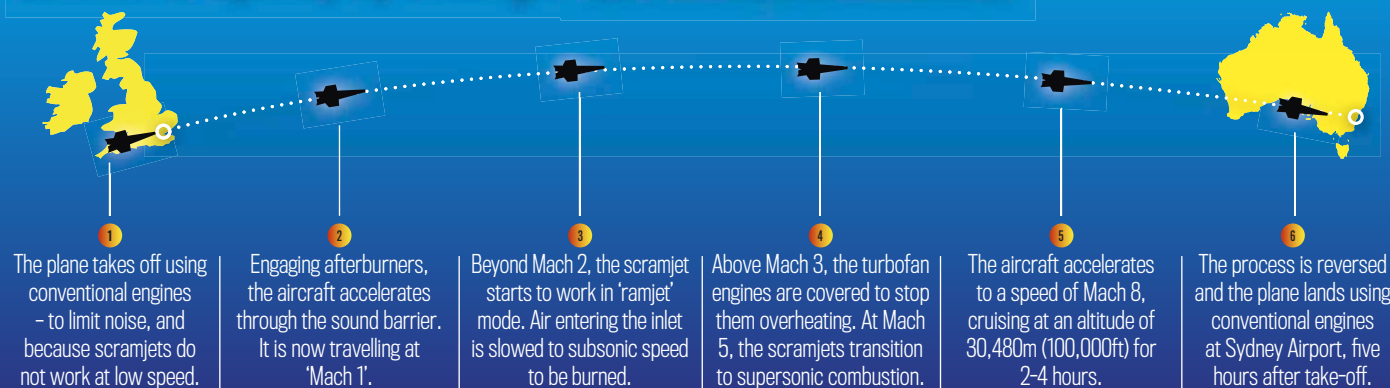
In Numbers

4,828km/h

or 2,999mph – Mach 5.1 – is the speed Boeing's X-51A reached in its test flight over the Pacific in May 2013. It flew at this top speed for 210 seconds.

London to Sydney by scramjet

How to fly to Australia in an afternoon



WHAT CAN I SEE ON THE SUN?



Don't miss *The Sky At Night* on BBC One every month
www.bbc.co.uk/skyatnight

Astronomy with
 Heather Couper
 and Nigel Henbest



AFTER A LONG silence, the Sun has started to muscle up again. The driver is the Sun's twisting magnetic field: as the Sun's poles and equator spin at different speeds, the field wraps itself around the Sun like an elastic band. The result? Regions of strong magnetism create more dark sunspots, and more towering clouds of plasma known as 'prominences' appear on the Sun's limb - just some of the features you can observe.

Pent-up magnetic energy is eventually released as violent solar flares and coronal mass ejections (CMEs). While difficult to observe with amateur equipment, CMEs are massive eruptions of solar material. Their power can lead to stunning aurorae above the Earth's poles and can even disrupt satellites. As activity ramps up there will be plenty to see. Follow this guide to observe the Sun safely (clouds permitting!).



SAFETY WARNING

Never use conventional optical aids to look at the Sun. Its radiation is so lethal that binoculars or a telescope could blind you. Only use the methods detailed below.

WHAT YOU NEED

Look at the Sun safely with this kit

SOLAR PROJECTION

Put a sheet of white card behind a telescope (or securely mounted binoculars). Point the telescope towards the Sun, and focus to produce a sharp image on the card.



CARDBOARD SUN PROJECTOR

Easy-to-assemble, this purpose-built projector has a lens and mirrors that throw an image of the Sun - up to 75mm across - onto a screen.



SOLAR FILTERS

Fit these metallised filters over the front end (*not* the eyepiece) of your telescope or binoculars to reduce the Sun's radiation to safe levels for direct viewing.



DEDICATED SOLAR TELESCOPE

A special filter, passing only light from hydrogen atoms, reveals details of the Sun's lower atmosphere as well as its surface.



Prominences

Visible with a PST, a prominence is a huge loop of glowing gas seen at the Sun's edge, supported by magnetic fields.

Sunspot

A dark region of the Sun's surface - sometimes as large as the Earth - cooled by powerful magnetic fields. The dark central region (umbra) is surrounded by the less intense penumbra.

HYDROGEN-ALPHA VIEW
 (dedicated solar telescope)

WHITE LIGHT VIEW
 (solar filter, solar projection)

Filaments

Seen against the Sun's disc, a prominence appears as a dark filament. When two touch, they can short-circuit as a brilliant flare.

Limb darkening

The Sun's glowing 'surface' is not solid, but the top of a globe of dense gas. Towards its edge, we look less deeply inside the Sun, and observe its cooler and dimmer upper layers.

Q MARINA ELLIS, HORSHAM

Why do hair and nails grow faster in the sun?

A THIS IS PROBABLY because exposure to sunshine increases the amount of vitamin D that is made in our skins, and this encourages the growth of nails and hair. Studies of the rate at which people's toe and finger nails have grown over the past 70 years show that in 1938, thumbnails grew at an average of 3mm a month, but that they have now speeded up to 3.55mm a month, probably because we have much better

diets today. So vitamins – including the vitamin D we get from sunlight – may well make a difference.

However, a study of human hair cells grown in the lab showed that exposure to UV light harmed them, and even killed the cells. So, as with so many things, moderation may be best. **SB**

Despite all the warnings, Roger had stayed out in the sun all afternoon



Q RACHEL WILLIAMS, SHROPSHIRE

Is BBQ food bad for you?

A MEAT CONTAINS CREATINE, an organic acid that helps to supply the energy used by muscle cells. When you cook meat, a chemical reaction turns creatine into a group of compounds called heterocyclic amines (HCAs) and there is some evidence that these compounds cause cancer in high concentrations. Frying and grilling meat will produce some HCAs but barbecues tend to be much hotter, and

worrying about underdone meat means that many of us tend to cook until everything is well charred, so the level of HCAs is much higher.

Also, unlike grilling, a barbecue heats the meat from below. As the fat drips onto the hot coals it burns, and the smoke rises up and coats the meat. This smoke contains lots of polycyclic aromatic hydrocarbons (PAHs) from the partially burned fat. PAHs are another group of chemicals that are known to cause cancer.

But so far most of the studies linking HCAs and PAHs to cancer have been in the laboratory, using rats and very high

doses. Most people don't eat barbecue food often enough for the health risk to be measurable. Even if you spend every Saturday afternoon in the sunshine drinking beer and eating burgers, the alcohol and the cholesterol are probably hurting your health a lot more than the HCAs and PAHs.

But if you are worried, a study reported in the *Harvard Health Letter* suggests you can reduce the level of these carcinogens by 90 per cent if you pre-cook your meat in the microwave for two minutes and then just scorch it briefly on the barbecue for flavour. **LV**



Australians rejoice!
There's little evidence
that barbecued food
presents a cancer risk

Is sunshine good for you?

With seemingly contradictory health advice appearing in tabloid newspapers on an almost daily basis, is soaking up the sun a good or bad idea? The answer, it turns out, is far from clear-cut... Words: Hayley Birch

THE ANCIENT EGYPTIANS worshipped the Sun god Ra, while we British celebrate the fleeting appearances of our nearest star with almost religious fervour. After all, there's nothing more cheering than throwing back the curtains in the morning to be greeted by that big ball of burning hydrogen. But sunlight doesn't just affect your state of mind – it affects your body. Too much and you risk getting skin cancer, too little and you could end up with bendy bones.

So while you're basking in the sunshine this summer, remember there are plenty of reasons to worship the Sun – and just as many to avoid it.



Four reasons to soak up the sun

1

RICKETS IS RUBBISH

Half an hour of sunshine will provide you with more vitamin D than you can consume in six tablespoons of cod liver oil or 200 eggs. Even a few minutes a week should be enough to stop you getting rickets – a painful bone-softening condition caused by vitamin D deficiency. A recent rise in rickets in the UK reported in the British Medical Journal has been blamed on children staying inside to play video games, but in reality the causes are probably more subtle. Darker skin makes you more susceptible to rickets, so a growing mix of cultural backgrounds may also be playing a part in the rise.

2

IT CHEERS YOU UP

There's a link between sunlight and the chemical serotonin, which influences mood and is important in anxiety disorders. Researchers at the Medical University of Vienna scanned the brains of people exposed to different levels of sunlight. The group who got less sun had 20-30 per cent lower levels of serotonin receptor binding. Post-mortems also suggest that people have lower levels of serotonin in the winter – as do hibernating squirrels. But feeling down could also be due to vitamin D. In a 2013 study, soldiers with very low vitamin D levels were more likely to commit suicide.

3

A HAPPY HEART

While the ultraviolet B (UVB) radiation in sunlight encourages your body to make vitamin D, ultraviolet A (UVA) radiation may help to lower your blood pressure. Researchers at Edinburgh University recently showed that sitting under a UVA lamp releases a chemical called nitric oxide in the skin. Nitric oxide makes blood vessels relax. In the study, this led to a 30 to 50 minute drop in blood pressure. Such a short burst won't stop you dying of heart disease, but the results are prompting scientists to wonder whether the UVA in sunlight could benefit heart health in the long term.

4

DITCH THE ITCH

Do you swell up if you swallow a peanut? It might be because you don't get enough sunshine where you live. In Australia, children in the less sunny south have been found to be more prone to egg and peanut allergies than children in the north who live almost 4,800km (3,000 miles) closer to the equator, and are almost twice as likely to develop eczema. The researchers at the Peninsula College of Medicine and Dentistry now want to discover if this link is due to vitamin D or to other factors such as temperature.



THE BURNING QUESTION

Life would be miserable without it, but is it safe to sit in the sunshine? Sunlight is undeniably the main preventable cause of skin cancer and we should heed advice on sun protection, says Edinburgh University dermatologist Richard Weller. But the myriad benefits of sunshine might make it worth risking the odd ray.

The link between sunlight and blood pressure is intriguing, particularly as World Health Organisation statistics show high blood pressure is now a leading risk factor for death globally. "It's well known that blood pressure is lower in summer than winter," says Weller. "However, when you give vitamin D tablets to people it has no effect on blood pressure. So I think the vitamin D is a measure of sunlight exposure, but perhaps not the only reason for the health benefits."



Four reasons to stick to the shade

1

TORTOISE FACE

Years of sun worship could leave you looking like Lonesome George. The combination of UVA and UVB radiation causes the skin to thicken and lose its natural elasticity, resulting in wrinkles and bags. We're more sensitive to sunlight when we're younger, revealed Australian researchers who digitally imaged skin damage in 18-83 year olds. So to avoid the tortoise effect in middle-age, stay away from the sun loungers in your teens and twenties. On the other hand, UV light is used to improve the appearance of the skin in conditions such as acne, psoriasis and eczema.

2

SKIN CANCER

Too little sunshine leads to low vitamin D levels, which put you at higher risk of certain cancers. But as far as skin cancer is concerned, it's too much sunshine that poses the problem. So the advice is to slap on the suntan lotion – even if the evidence can sometimes seem misleading. For instance, a 2009 Scandinavian study found some of the highest rates of melanoma in doctors and dentists, while fishermen and forestry workers were far less affected. The researchers concluded that those who worked outside were constantly exposed to sunlight, and so less likely to get burnt.

3

TANNING ADDICTION

Some regular beachgoers show signs of substance abuse, dermatologists carrying out a survey of visitors to Galveston Island beach in Texas discovered. The addictive 'substance' in this case, though, wasn't alcohol, tobacco or illicit narcotics – it was UV radiation. The sensation of UV radiation on skin generates such a feeling of well-being that the desire to repeat it can become a physical dependence. Indoor tanning can be just as addictive. In one 2006 study, US scientists gave sun bed addicts naltrexone, a drug used to treat alcoholics, and showed it could temper their need to tan.

4

GOING BLIND

Staring at the Sun without sunglasses hurts – reason enough to avoiding doing it. But direct exposure to the UV radiation in intense sunlight can also damage the eye and increase the likelihood of a cataract developing. Cataracts affect the part of the eye that focuses light – the lens – gradually clouding vision and leading to blindness if left untreated. Surgery to restore vision involves making tiny cuts in the eye to remove the cataract and replace the lens. To avoid this, a study by Fordham University scientists recommends preserving your peepers with UV-filtering wraparound glasses.

Q LUCY BROOKS, HARROGATE

Why does cut grass smell so good?

A YOU ARE SMELLING a mixture of oxygenated hydrocarbons that include methanol, ethanol, acetaldehyde and acetone, called green leaf volatiles (GLV). We like the smell because we have come to associate it with summer and weekends.

The smell isn't just an accidental by-product of the cut leaves, however. There is some evidence that plants deliberately emit volatile compounds in response to damage. Wild

tobacco plants, for example, emit a certain GLV only when they are being grazed by caterpillars. This acts as a signal to attract nearby bugs that prey on the caterpillars. **LV**

Be kind to your nose:
mow the lawn

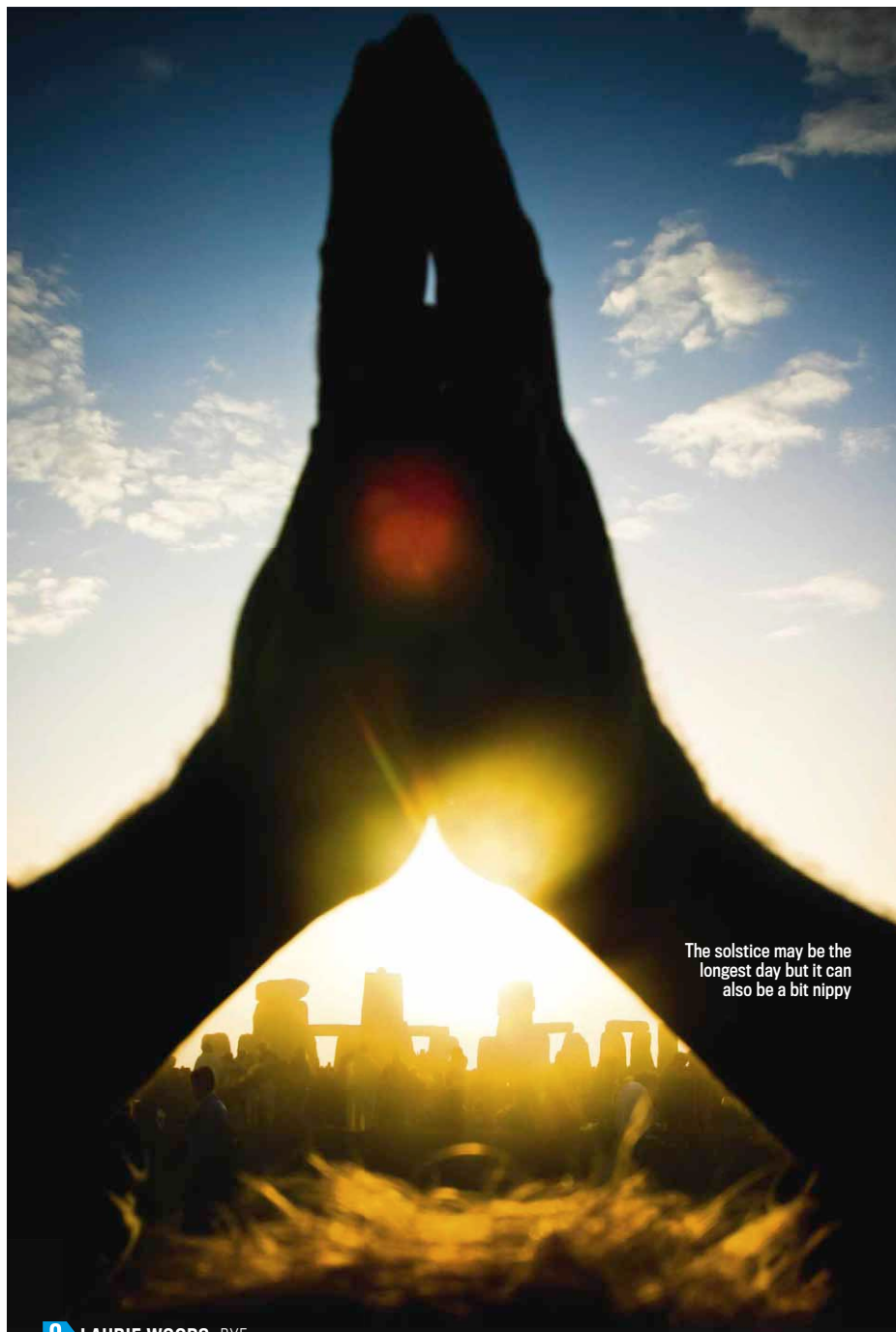


Q JAMIE HASTINGS, BROMLEY

Will a glass filled to the lip with ice and water overflow when the ice melts?

A ICE TAKES UP slightly more volume than the water it's made from, so when it melts, the parts of the ice-cube poking out of the water and seemingly threatening a spillage just shrink back, preventing any overflow. This is also why the melting of floating sea ice by global warming won't raise sea levels. **RM**

Cool off this
summer with plenty
of overflow-free ice



The solstice may be the
longest day but it can
also be a bit nippy

Q LAURIE WOODS, RYE

Why isn't the summer solstice the hottest day of the year?

A THIS IS DUE to what is called 'seasonal lag', which occurs because the air isn't directly warmed by the Sun. Instead, the Sun's radiation warms the sea and the land, and they then warm the air by conduction. It takes a long time to warm up the land and even longer to

warm up the sea, so they don't reach their maximum temperature until well past the solstice. In the UK this occurs in July and August, but San Francisco, which is surrounded on three sides by the sea, doesn't reach its peak temperature until mid-September. **LV**

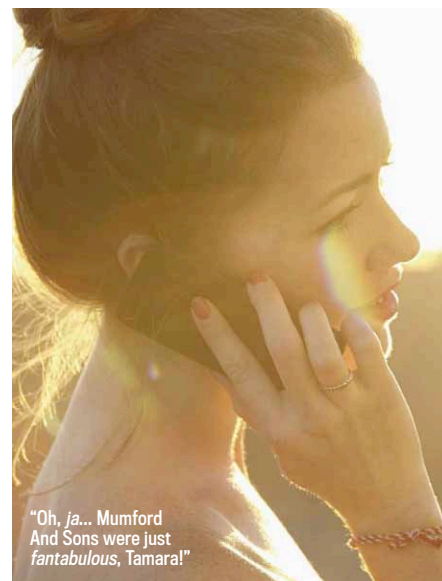
Q BEN MOORE, GLASGOW

Are mobile phone signals stronger in hot weather?

A TEMPERATURE HAS NO significant effect on mobile signals. But moisture can attenuate radio waves through the air slightly. In other words, it can absorb the signals and weaken them, so you may have marginally poorer reception in heavy rain or high humidity. Mobile phone signals are in the microwave band at a wavelength of about 15 to 30cm, in a radio frequency sweet spot where atmospheric attenuation is at a minimum. However, water molecules absorb a small amount of energy even in this band.

Radio waves are also affected by electrical storms when air molecules become ionised. So if hot weather triggers thunderstorms, it can disrupt phone signals in this way.

Other phenomena that can affect mobiles and indeed all communications are those from beyond our world. Space weather, caused by phenomena such as solar flares, causes streams of charged particles to breach the magnetosphere, bombarding the communications infrastructure and disrupting mobile phone traffic. **GM**

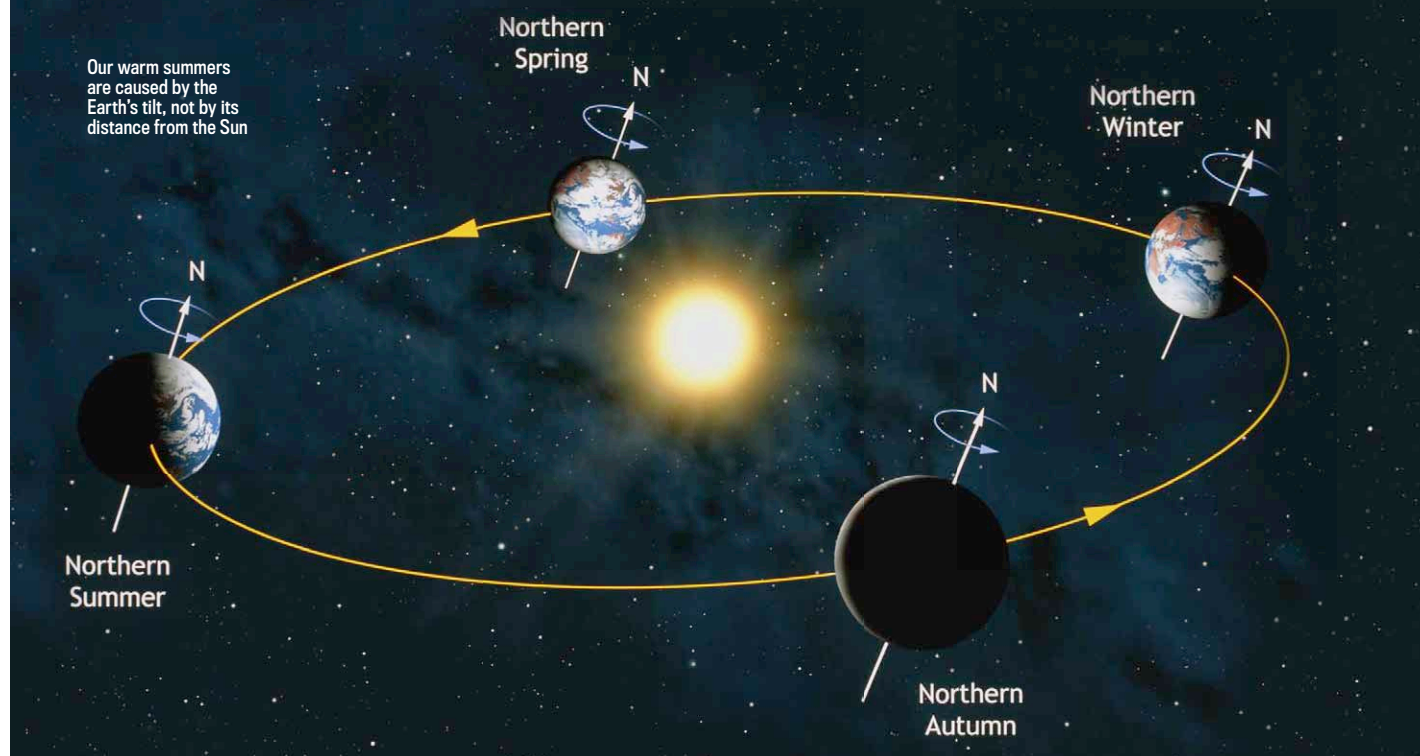


Q ALI RIPLEY, CIRENCESTER

Are we closer to the Sun in the summer than in the winter?

A SURPRISINGLY, NO. SINCE the Earth's orbit is slightly elliptical, its nearest distance to the Sun (called 'perihelion') is about 147 million kilometres and its furthest (called 'aphelion') is about 152 million. This 3 per cent or so difference means the Sun's light is on average 7 per cent stronger at perihelion than at aphelion. But perihelion actually occurs in early January, in the dead of winter for the northern hemisphere! This isn't as contradictory as it seems because in

fact the Earth's elliptical orbit has very little to do with the seasons. The seasons are caused by the 23.5° tilt of the Earth's spin axis. This means that as the Earth moves around its orbit, first one and then the other hemisphere tilts toward the Sun. The hemisphere tipped toward the Sun experiences summer because it receives up to three times as much energy as the other (winter) hemisphere, as well as having more hours of sunlight. **AG**



What's the best way to stay cool?

What to wear, what to drink and how to chill your house: science has the answers this summer

Words: James Lloyd

1 SHED A FEW LAYERS

OUR BODIES HAVE cooling sussed. When we get hot, we sweat, and as that sweat evaporates it draws energy in the form of heat from the skin, cooling us down in the process. So the best way to stay cool if you're out of direct sunlight (and in sympathetic company) is to wear nothing at all. If you do need to cover up, wear loose-fitting clothes that allow air to flow over the skin, speeding up evaporation.

2 EXERCISE IN SPORTSWEAR

HIGH-TECH SPORTSWEAR cools you down with a process known as 'moisture wicking'. This is achieved by combining hydrophobic (water-hating) fibres like polyester with a hydrophilic (water-loving) fibre, so that the moisture is first absorbed and then repelled by the material. Once it reaches the fabric's outer surface, the moisture can spread out and evaporate.

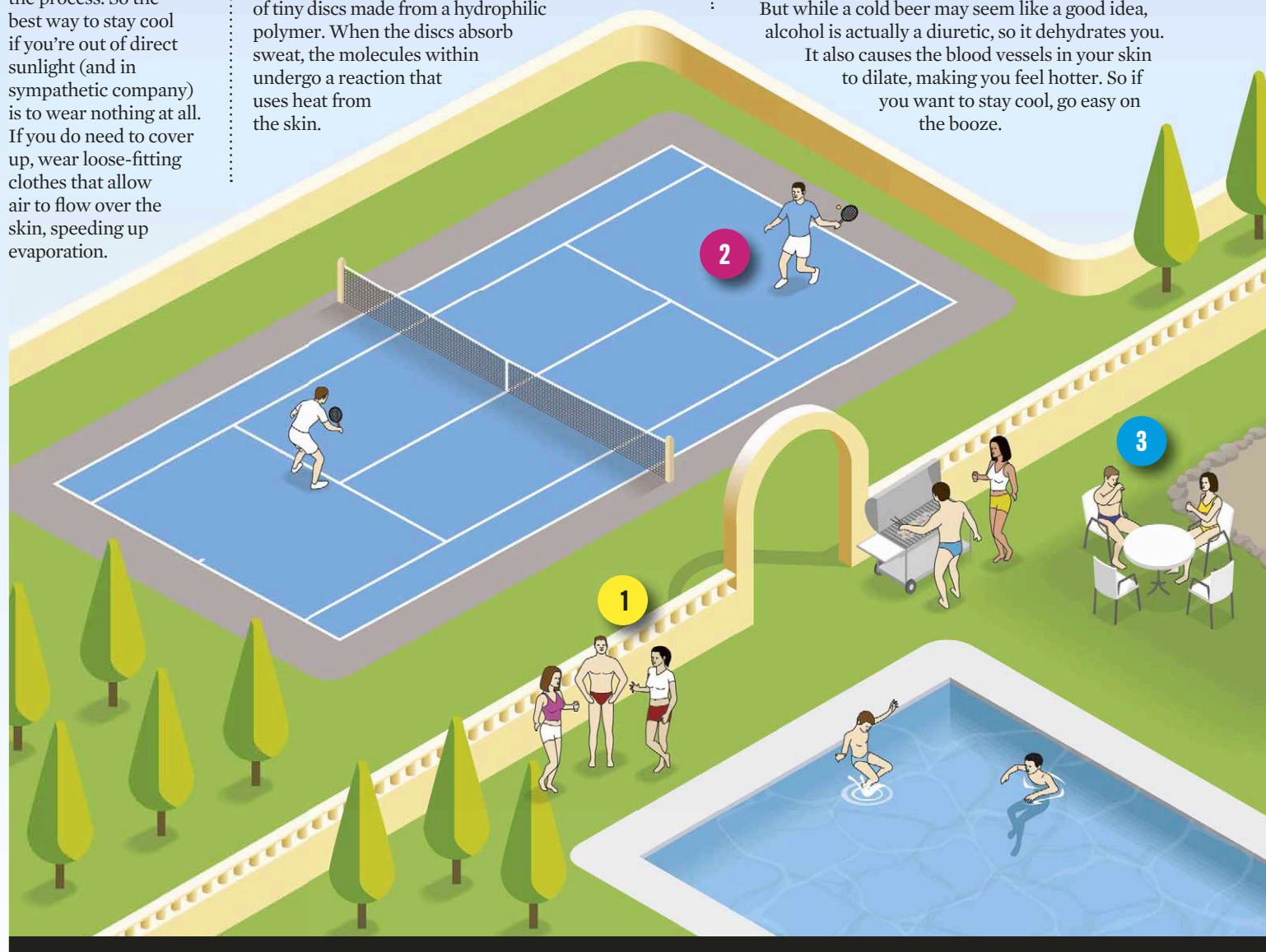
Going one better, sportswear company Columbia this year launched its 'Omni-Freeze ZERO' range. These clothes are embedded with thousands of tiny discs made from a hydrophilic polymer. When the discs absorb sweat, the molecules within undergo a reaction that uses heat from the skin.

3 HAVE A COLD DRINK...

AS YOU SWEAT, you'll need to replace the water you're losing. "Urine colour is an easy way to figure out your hydration status," says Dr Douglas Casa, a heat stroke expert at the Korey Stringer Institute at the University of Connecticut. "If it's light like lemonade then you're fine; if it's dark like apple juice then you're dehydrated." When you become dehydrated, the body slows down its sweat rate to conserve fluid, making you even hotter. So a cold drink can rehydrate you and help cool you down.

But while a cold beer may seem like a good idea, alcohol is actually a diuretic, so it dehydrates you.

It also causes the blood vessels in your skin to dilate, making you feel hotter. So if you want to stay cool, go easy on the booze.



4 ...OR A NICE CUP OF TEA?

TRAVEL TO A hot country and chances are you'll find someone sipping a hot drink on a scorching day. It may seem crazy, but it has a scientific basis. Last year, researchers at the University of Ottawa found that cyclists who drank hot water actually had less heat stored in their bodies than those who slurped cool drinks. The hot drink caused the cyclists' sweat rate to increase, creating a cooling effect that overcompensated for the added heat from the drink.

"The only caveat is that this extra sweat has to evaporate for the cooling to outweigh the drink's heat," says Dr Ollie Jay, who led the study. "It only works if you're in a dry environment, wearing loose clothes."

5 DON'T OPEN ALL THE WINDOWS

TO CREATE A refreshing breeze on a stifling summer's day, don't haphazardly throw open the windows. Instead, generate a draught by opening downstairs windows that are in the shade, and upstairs windows that are in the Sun.

Because hot air rises, sunny upstairs rooms will be warmer than those that are downstairs in the shade. This sets up a pressure difference, and by strategically opening windows in these rooms you'll create a breeze that draws in cool, fresh air from downstairs and forces warm air out of the house. The effect can be increased by using window-mounted fans.

6 INSTALL A COOL ROOF

WHY NOT CUT your summer energy bill by installing a 'cool roof'? White or light-coloured roofs reflect more sunlight and absorb less heat than conventional roofs, helping to cool the building down. Alternatively, try nurturing a rooftop garden. Vegetation planted on a roof can shade the building from sunlight and reduce the roof's temperature as water evaporates from the soil and plants. A 2003 study in Canada found that a green roof could reduce the daily energy demand for air conditioning by over 75 per cent.

7 BUY A WINDOW FILM

ONE WAY TO keep your house cool is to close all the curtains and shut out the sunlight. But that might give your neighbours the wrong idea.

A better solution is to buy a window film – a thin, transparent layer that fits onto the inner surface of a window. These films let through most of the Sun's visible light but act as a barrier against infrared light, which heats up objects, and ultraviolet light, which causes sunburn. The most effective films are made by coating a polyester base with metals or other chemicals. Titanium nitride coatings, for example, are especially good at reflecting infrared radiation. ■



Q SIMON LEIGH, LUTTERWORTH

Where does the term 'dog days of summer' come from?

A THIS ANCIENT TERM refers to the period of hot weather that, in the northern hemisphere, commonly occurs in July and August. It comes from the fact that the star Sirius (the 'Dog Star' in the constellation of Canis Major, the Greater Dog) rises with or just before the Sun during this time. Ancient astronomers incorrectly imagined that the simultaneous appearance of the brightest luminary of the day (the Sun) and the brightest star of the night (Sirius) was responsible for the extreme heat of the 'dog days'. **AG**

Sirius rises with the Sun during the year's hottest months, giving us the expression 'dog days'

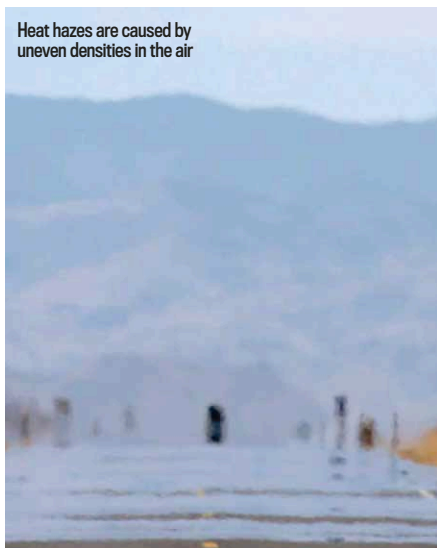


Q FRED CHURCH, BRISTOL

What causes heat haze?

A THE APPEARANCE OF objects depends on the optical properties of the air between us and the object – which in turn are affected by the density and temperature of the air. Any source of heat, such as the Sun, can cause uneven changes in density which trigger the optical distortions we see as rippling heat haze. **RM**

Heat hazes are caused by uneven densities in the air



Q CHARLIE DENNIS, SHEFFIELD

How does air conditioning work?

AC units essentially turn your room into a giant fridge

A WARM AIR FROM your room is blown over some coils containing compounds called refrigerants that change from liquid to gas. This 'phase transition' to a gaseous state absorbs heat and cools the air down. The

refrigerant then goes through a compressor to turn it back into a liquid before completing the loop by returning to the cooling coils. A fan outside extracts both the room heat and that given off by the compressor. **GM**



Q KARL WEIR, BRIGHTON

How does sunscreen work?

A SUNSCREEN USES A mixture of organic and inorganic particles to block potentially harmful UV radiation in the Sun's light. The organic particles (usually octyl methoxycinnamate or oxybenzone) absorb the rays and dissipate them in the skin as heat, preventing burning. The inorganic ones (titanium dioxide and zinc oxide) reflect and scatter the radiation, forming a physical barrier. It was these inorganic components that used to make sunscreen appear white. But nowadays the particles are small enough to be invisible, so sunscreen can be clear and still protect your skin.

As the diagram shows, there are three types of UV radiation in sunlight – A, B and C – and a sunscreen's SPF factor measures only the amount of UVB protection provided. SPF is often thought to mean that if you would burn in an hour, then with SPF 15 you can stay outside for 15 hours. This is a simplified picture, however. At midday there is far more UV radiation, since the Sun is lower in the sky. So the time we can safely stay outside depends on the time of day, as well as on how much sunscreen we've applied and how well it's been absorbed by the skin. It takes time for sunscreen to be absorbed, which is needed for it to be fully effective.

Components of sunlight

Wavelength: 400-315nm

Wavelength: 315-280nm

Wavelength: 280-100nm

UVC

UVC radiation need not worry sunbathers: its very short wavelengths are blocked by the Earth's atmosphere before it even reaches you.

UVB

UVB is the component of sunlight that is responsible for sunburn. It can also cause skin cancers if you're exposed to too much of it. The SPF factor of a sunscreen is a measure of how much UVB protection it affords.

UVA

Not all sunscreens protect against UVA, but it is well worth finding one that does. Over-exposure can cause skin cancer but, because its longer wavelengths penetrate the skin more deeply than UVB, it has no visible tanning or burning effect.

NEXT MONTH Over 20 more of your questions answered



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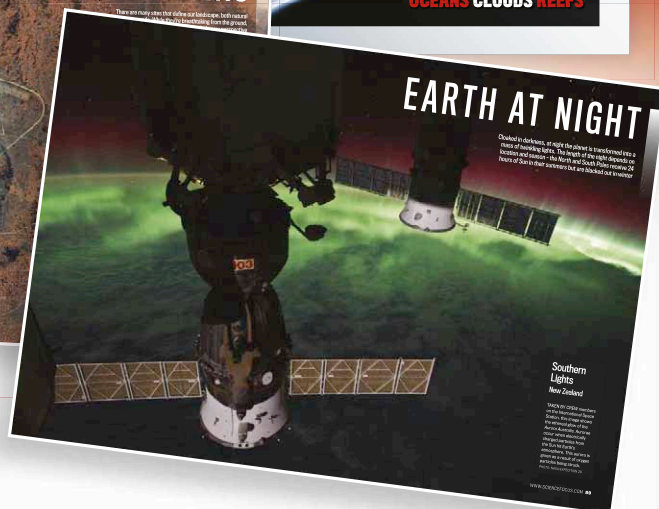
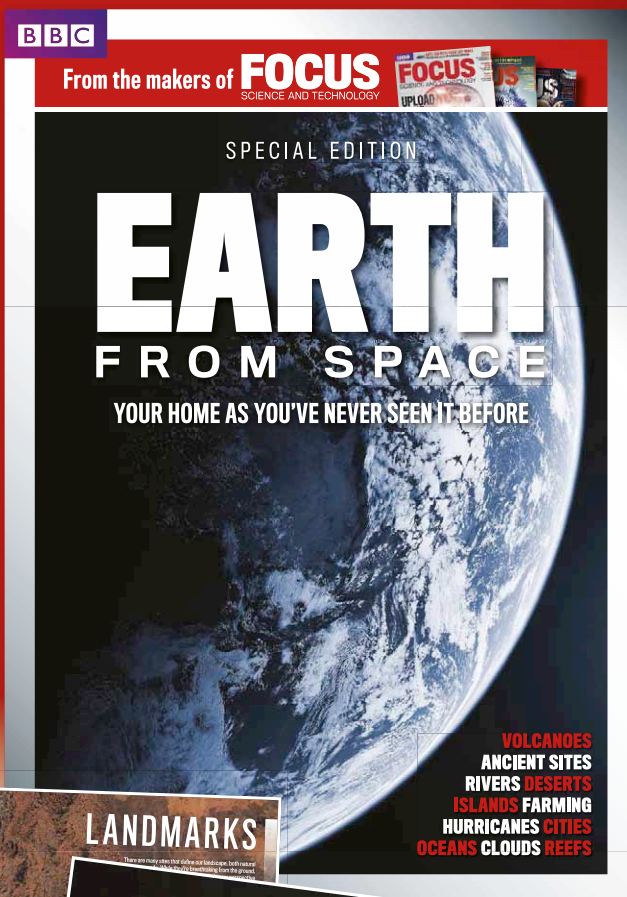
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MEET THE



**Our homes are our castles:
places where we feel safe. But
we are seldom at home alone...**

Words: Professor Adam Hart

THANKS TO THE wonders of the scanning electron microscope, we have unprecedented views of the tiny creatures with which we coexist. We share our homes with a diverse array of organisms that take full advantage of the warm, safe, food-rich habitats we provide. As we move into the warmer summer months the numbers of these rent-free lodgers often increase dramatically. So, take this safari around your own home – you may be repulsed to find out who you're sharing it with.

LODGERS

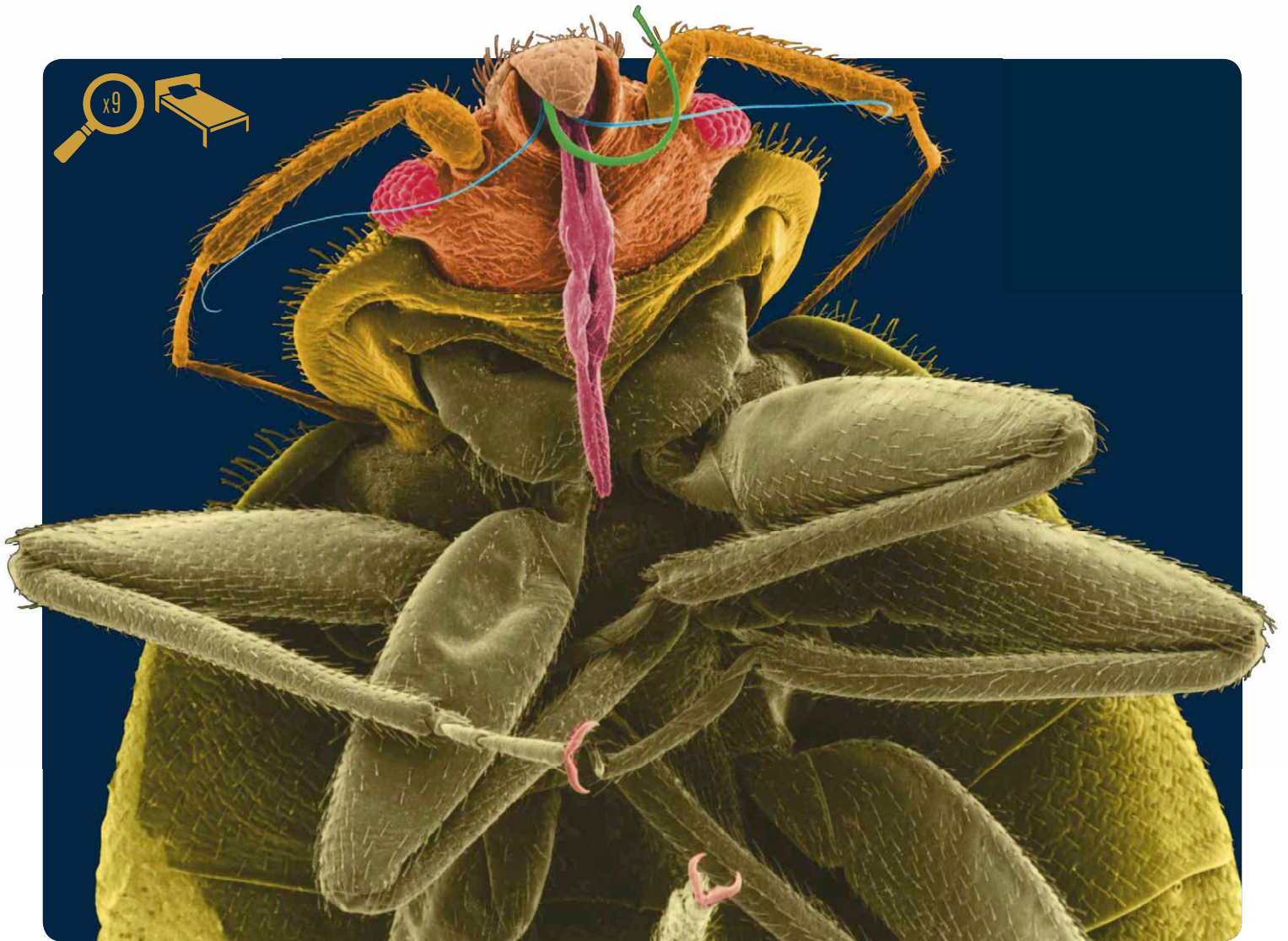


PROF ADAM HART
recently presented BBC
Four's *Planet Ant: Life
Inside The Colony*

CAT FLEA

THESE HIGHLY SPECIALISED wingless insects are ectoparasites – parasites that live on the outside of their host. The mandibles – the saw-like structures protruding below the jaw – pierce the host's skin allowing the flea to get a blood meal. The cat flea (*Ctenocephalides felis*) does not generally infest humans. However, they can bite us and cat owners will be only too aware of the problems fleas can cause their animals. Fleas develop from eggs that hatch to form larvae that resemble tiny maggots. Larvae feed on dried blood from adult flea faeces before pupating, eventually emerging as adults and jumping onto a host. Although fleas are the vectors of disease, they are beautifully adapted for their parasitic lifestyle. →

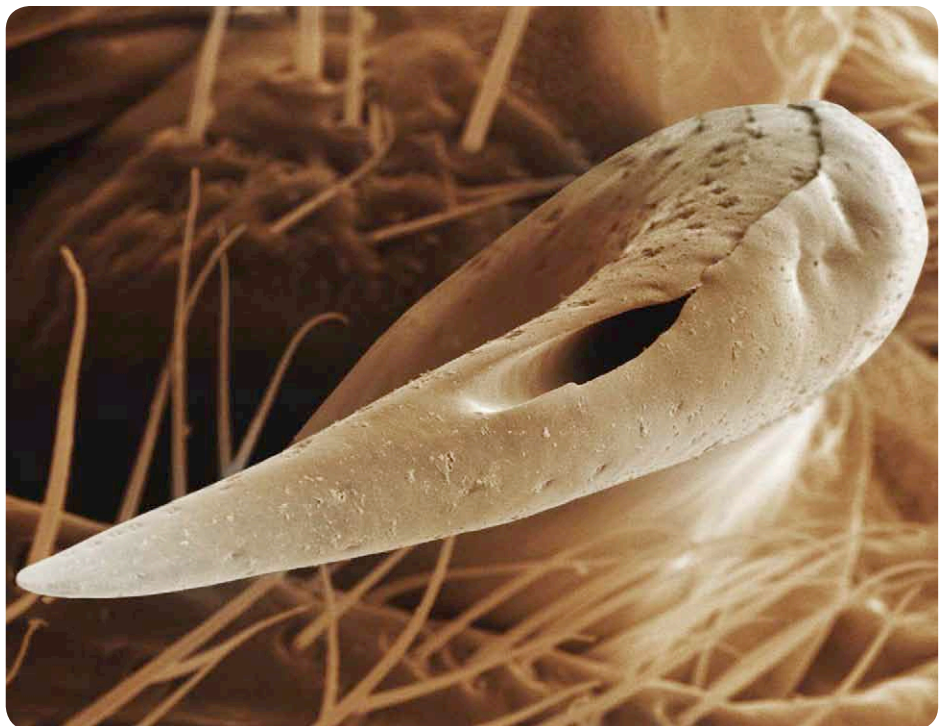




BED BUG

CIMEX LECTULARIUS, OR the bed bug, belongs to the insect order Hemiptera. Many Hemipterans use their piercing mouthparts to feed on plant sap, but bed bugs have become ectoparasites. They use their stiletto-like mouthparts to pierce our skin to feed on blood. They have flattened bodies and have lost their wings. These adaptations enable them to live undetected in our mattresses and furniture, while also allowing them to expand their bodies after a large blood meal.

In the animal kingdom, females can exercise considerable control over mating, blocking copulation, being picky during courtship and even ejecting semen from certain males. In bed bugs, this has resulted in the evolution of traumatic insemination. The male's curved, dagger-like 'stabbing penis' [pictured right] pierces the female's body, circumventing the reproductive tract and, therefore, any female control. This means that the male is able to deposit his sperm directly into the female's body cavity, where they migrate towards the ovaries.





EYELASH MITES

TO THESE MICROSCOPIC mites (*Demodex folliculorum*), our eyelash follicles – the cavities in the skin containing the eyelash roots – are warm, food-filled caves. Eyelash mites are relatives of the spiders and can also be found in follicles in the nose and ear canal. They feed on oily secretions from sebaceous glands and dead skin cells and are not generally harmful. Technically, they are known as ‘commensals’ – organisms that gain benefit from another organism without causing harm. Sometimes, however, people can develop an allergy to *Demodex* and when this occurs, they can cause hair loss and other symptoms such as acne.



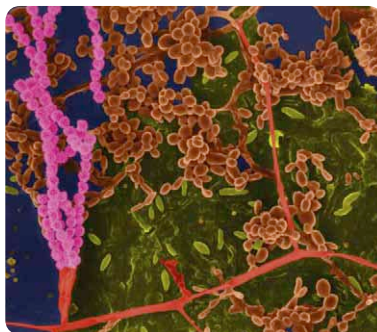
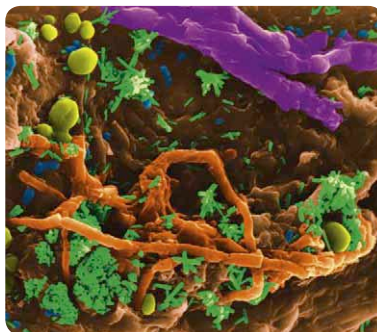


PHOTO: SCIENCE PHOTO LIBRARY X2. CORBIS X2

DUST MITE

Dermatophagoides pteronyssinus are, like eyelash mites, arachnids – relatives of the spiders and scorpions. However, at around 0.4mm long, dust mites are smaller than a full stop. They have unsegmented bodies and their mouthparts (seen in this photograph at the lower centre) are highly specialised for feeding on the skin scales that are found in household dust.

As they feed they produce faecal pellets and partially digested particles containing proteins. Breathing these in causes our bodies to produce antibodies in response to them, releasing histamines. Inhalation of dust mite excreta can therefore give some people similar symptoms to hay fever or asthma. Washing bedding regularly and minimising the build-up of dust can help to control the problem.

**KITCHEN CRITTERS**

YOUR WASHING-up sponge is an ideal habitat for bacteria and fungi [left, top].



Their spongy structure gives them a huge surface area and they are usually damp, warm and loaded with food particles. The green and blue rod-like structures in this photomicrograph are bacteria, the yellow-green spheres are yeast fungi and the purple and orange filaments are filamentous fungi. Their waste products give dirty sponges their unpleasant odour.

Cracks and crevices in cutting boards [left, bottom] also provide excellent habitats for bacteria. Bacteria can form biofilms, where many cells stick together on a surface embedded in a matrix of substances that the bacteria produce. The formation of biofilms can make bacteria much more difficult to eradicate. Poor hand hygiene when preparing food can lead to harmful bacteria like *Salmonella* and *Escherichia coli*, causing food poisoning.

**CLOTHES MOTH**

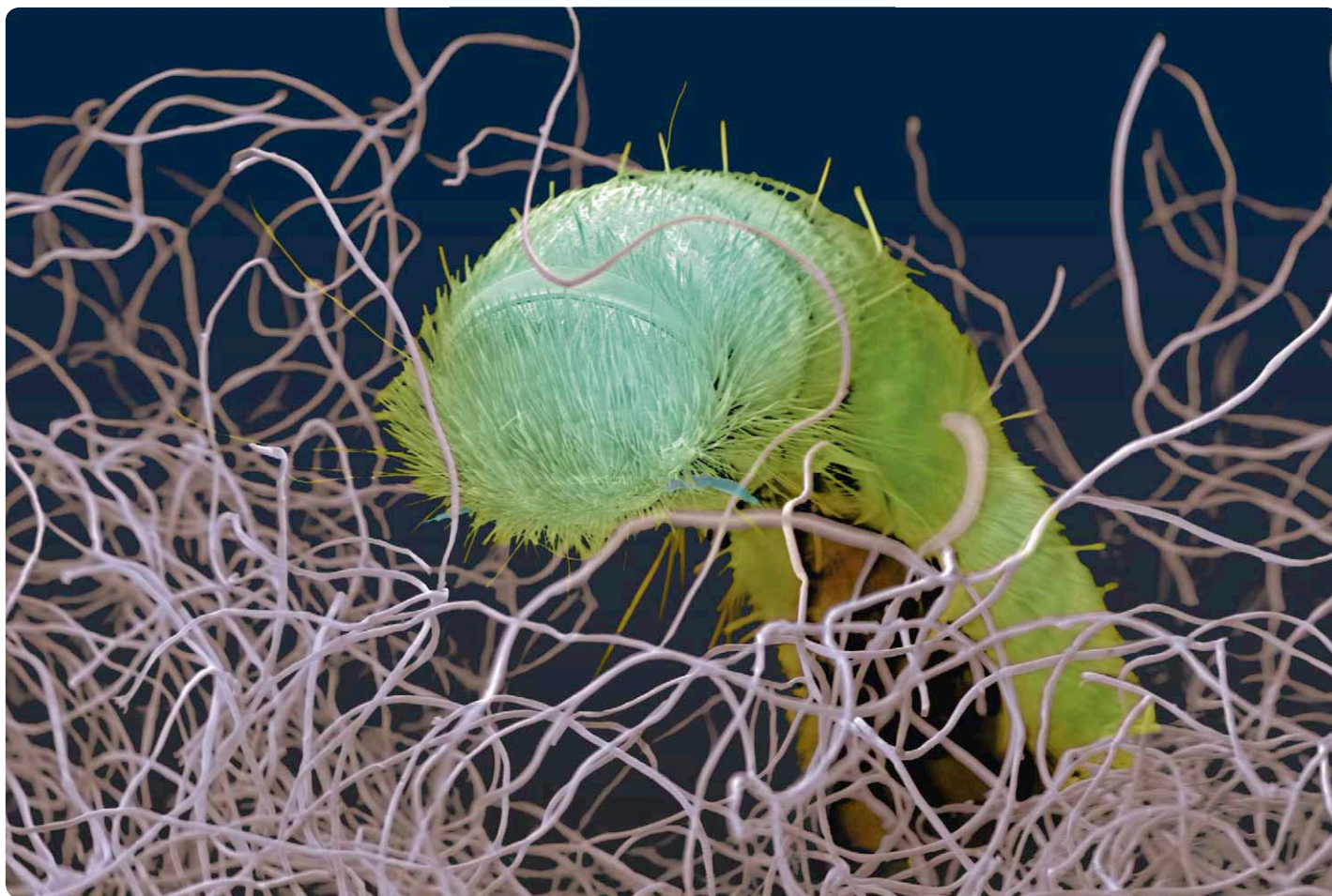
THESE MOTHS ARE unusual because the caterpillars mainly feed on lichens, fungi and dead plant material, rather than living plants, and they have become adapted to feeding on natural fabrics including wool, cotton, linen and silk. Part of the moth family *Tineidae*, adults lay tiny eggs on clothes and the caterpillars can develop into a pupa in as little as two months or as long as two years, depending on conditions. After a month or two as a pupa, the adults emerge to continue their life cycle within our wardrobes.





DENTAL PLAQUE

A BACTERIAL BIOFILM with which we are all familiar is the sticky coating of dental plaque that grows on our teeth, shown here on a toothbrush bristle. Plaque is a film of as many as 1,000 species of bacteria lying within a matrix of glycoproteins (proteins with polymers of sugar molecules attached). As the bacteria feed on the sugars in our food they produce acidic waste products that corrode tooth enamel, leading to dental decay. Dental plaque build-up can also lead to gum disease and loss of teeth.



CARPET BEETLE LARVAE

SOMETIMES KNOWN AS 'woolly bears', carpet beetle larvae **[top]** mature into fully-fledged adult beetles **[bottom]**. They belong to the family *Dermestidae*, which are scavengers, and their larvae are also opportunists, making them a pest. Larvae develop from eggs laid in dark, undisturbed areas and consume items like furs, feathers, furniture, clothing,

blankets and carpets. As a result, Dermestid beetle larvae can be a major problem for museums.

As the larvae move they shed some of the hairs (or setae) that give them their nickname of woolly bears. These can cause irritation either through contact with the skin or by being inhaled. Skin contact can cause small itchy welts that are sometimes confused with bed bug bites. ■

ADAM HART is Professor of Science Communication at the University of Gloucestershire, and recently presented BBC Four's *Planet Ant*

Find out more

bit.ly/18obBdw

Information about controlling dust mites from AllergyUK.org

THE GOSPEL ACCORDING TO STEVE JONES

In his new book, the outspoken geneticist retells stories from the *Bible* with the help of science. It leads to some surprising twists to the tales... Interview by: Andy Ridgway



Steve Jones is
the author of
*The Serpent's
Promise - The
Bible Retold as
Science*

Your new book's subtitle is *The Bible Retold As Science*. Are you kidding?

I'd say there are a lot of scientific questions in the *Bible*. I'm less sure there are a lot of scientific answers. Science is fundamentally about asking sensible questions and the Bible asks some very sensible questions. Where do we come from? What's the meaning of sex? Why do diseases suddenly appear? Are we born good or evil? What is the meaning of the visions people sometimes see? All these things are fundamentally scientific questions. It's not unreasonable that two or three thousand years ago people were simply not in a position to answer them. But now, more and more, we are.



→ **In the book you say Adam and Eve would never have met - in fact they would have lived about 100,000 years apart. How did you reach that conclusion?**

If you want to see the difference in the date of the last common male ancestor – the last man who is the ancestor of every man alive today – and the last woman who was the ancestor of every man and woman alive today, you can go back through the genes. You can trace male lines of descent down the Y chromosome [the

“Science doesn’t explain the start of life. It’s hard to know how we’ll ever come to a conclusion”

chromosome only found in males] – it’s passed from father to son and grandson and so on. And you can trace the female lines of descent through the DNA in the mitochondria [the ‘power plants’ within cells]. It is passed by mothers to sons and daughters, but only daughters then pass it on.

So are you looking for similar genes in the Y chromosome and mitochondrial DNA?

Yes. Genes are a bit like surnames – they change slowly with time. When you trace the genes back, the last common male ancestor appears 100,000 years earlier than the last common female ancestor.

Why might that be?

You can see the answer in one of the Biblical stories – the story of King Solomon. I think he had 700 wives. Now if all the 1,000 or so kids running around his court were to ask who was their last male ancestor, it would be King Solomon. But if they were to ask who was their last female ancestor, they would have 700 different mothers. Those mothers would probably have 500 different mothers and so on back into history. So you would have to go a lot further back to get to the last common female ancestor than you would the last common male ancestor.

On a wider scale, because there is much more variation in male mating success, with some males having enormous sexual success, inevitably others had no success. As a result, effectively you get back to Adam, the common male ancestor, much sooner than you do to Eve. This means that everyone in the world has got probably twice as many great, great, great and so on grandmothers as they do great, great, great and so on grandfathers.

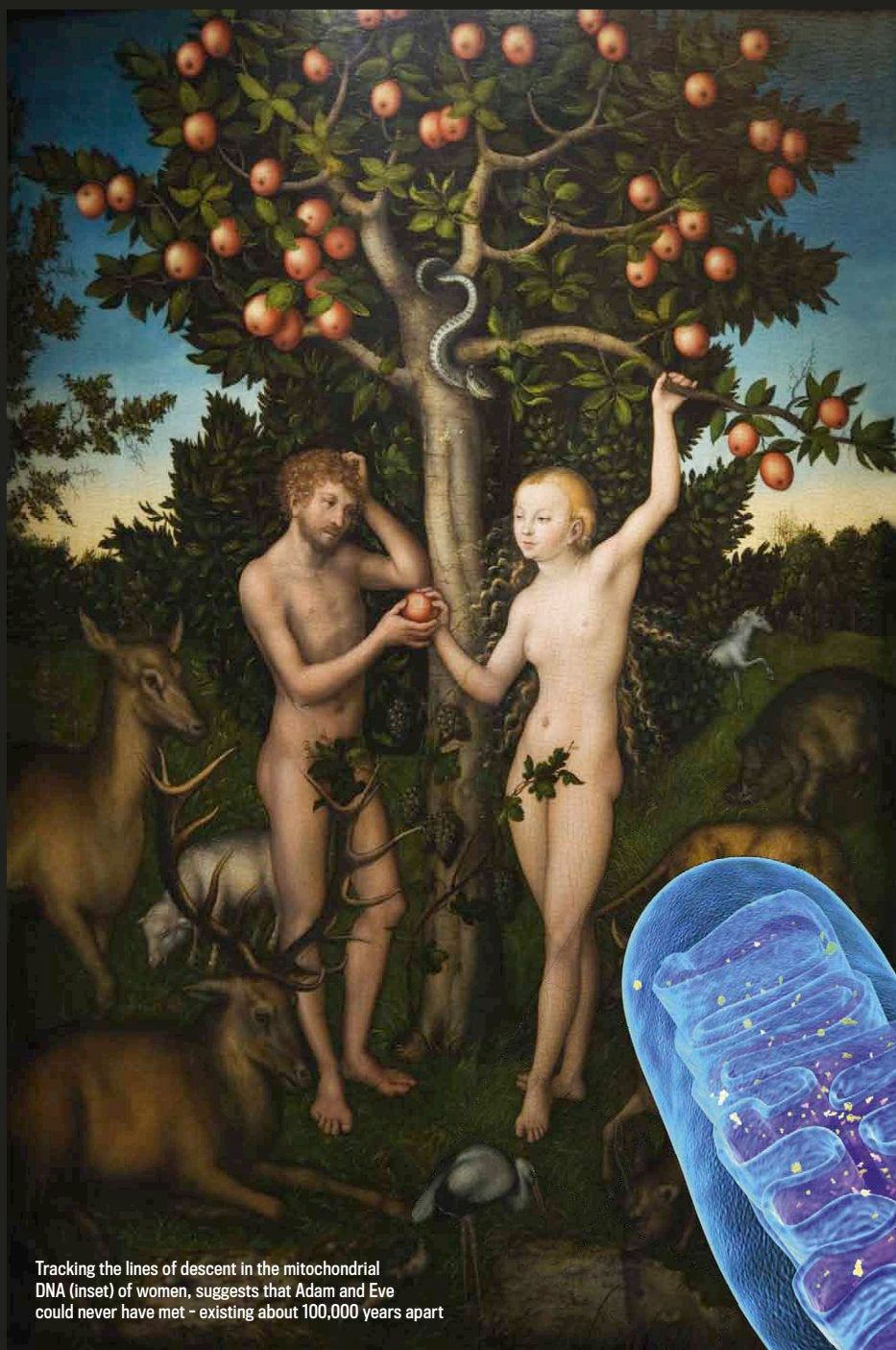
The Bible says that God created all living things - how does science explain the start of life?

The short answer is that science doesn’t explain the very start of life. There are many theories, but it’s hard to know how we’ll ever come to a conclusion.

The one thing that is pretty clear is that all life today starts from a common ancestor. There weren’t 30 separate origins of life, for instance. Or at least there might have been, but 29 of them went extinct.

How do we know that?

Well, if you look at the genetic code it’s effectively universal. We all share the



Tracking the lines of descent in the mitochondrial DNA (inset) of women, suggests that Adam and Eve could never have met - existing about 100,000 years apart



King Solomon wasn't a great believer in monogamy, with 700 wives and 300 concubines in his harem

same agent of inheritance, DNA, and the three-letter code that contains its information is also universal. Quite how that happened is speculative, but it does give a hint that we all – from amoeba to man – descend from the same ancestor.

One of the key differences between the origin of life and the origin of the Universe – and it really points at the difference between biology and physics – is that biology digs up its own fossils. In the exploding Universe, the most distant objects are the oldest and you can reconstruct the pattern of the explosion because all the fragments are still there. But in biology, natural selection rises upon piles of corpses to higher things. ➔

The Big Bang: the hand of God or currently unknown scientific explanation?

STEVE JONES ON THE BIRTH OF THE UNIVERSE

“ IN THE VERY beginning there was a sudden expansion, a Big Bang, from a single point. Much of what we understand about the beginning of the Universe is from 10^{-43} seconds after that point, when elementary particles collided to give us matter and antimatter. Under the

influence of gravity, this early chemistry combined into the stars and galaxies.

But exactly what sparked the Big Bang in the first place is a mystery. Believers say God did it: God sneezed and it all began. But that's not an explanation, it's an excuse – you can't test that theory. And if you can't test it, it's

not a useful theory.

Science doesn't currently have the answer either. Attempts to understand the skies from the Big Bang to the present day – to get mathematics to fit reality – are turning up suggestions almost beyond comprehension. Might there be an infinity of other Universes out there, some of

them precise copies of our own? Where is the undiscovered nine-tenths of the Universe – the dark energy and dark matter – that might cause its expansion to accelerate or slow down? We don't know. When explanations emerge, they will be at an intellectual pole most of us will never reach. ”



The number of animals on board the Ark brought new meaning to the term 'poop deck'

STEVE JONES ON NOAH'S ARK

“ THE ARK MUST have been a crowded place with all those animals. Genesis gives the Ark's length at 300 cubits – 137m. That's the same length as the schooner Wyoming – the largest wooden vessel of modern times. Her extreme length and wooden construction meant she

flexed in heavy seas, allowing seawater in. In the end, she was lost with all hands in 1924.

There's also the question of where the Ark came ashore. So far, a million dollar prize offered by a Christian foundation for physical evidence of the craft remains unclaimed. In 1949 a US Air Force aerial reconnaissance mission photographed an object near the summit of Mount Ararat in Turkey. It was suggested by some to

be the remains of the Ark, but it turned out to be nothing more than a patch of discoloured ice.

Even an astronaut has hunted for the Ark. In 1972, a year after becoming the eighth man to land on the Moon, Jim Irwin left NASA and went on to lead six expeditions to Mount Ararat hoping to spot signs of the Ark. However, he died in 1991 before he succeeded in his quest. ”

➔ Nearly all of the previous species are driven out by the improved versions that appear in later generations. So we would never hope to find the series of ancestors that represent the transition from the 'Big Bang' of life to the millions of species we see today.

It sounds like a question we will never ultimately answer through science...

Well, it's hard to know. We know a lot more about the origin of life than we did. There's a lot of interesting new knowledge about the way undersea structures called white smokers work. They have warm water coming out of them and act as templates that allow the earliest constituents of life – things like nucleic

Jeanne Calment defied God's age-limit when she celebrated her 122nd birthday



acids and proteins – to adsorb [the adhesion of molecules] onto their spongy surfaces and undergo chemical reactions that get the system going.

In the Bible, God says that we'll live no more than 120 years. But do you think modern medicine will allow us to live longer than that?

I don't think we will ever get there. But the facts are remarkable enough: human life expectancy has been going up by six hours a day every day in the Western world for the past 100 years and it's showing no signs of slowing down. There seems to be a cutoff: there is a huge number more 70-year-olds than there

“It’s hard to deny the temptation to describe some of the visions of the saints in terms of mental disorder”

were 200 years ago and there are many more centenarians than there were 100 years ago, but there are no more people of 120. So it looks like there may be a biological block to the process.

But don’t you think we’ll be able to push through that block with the likes of genetic engineering?

The short answer is no. Infectious disease has for the time being, in most places, been conquered. So we have to face the enemy within, which is our own intrinsic biological weakness.

In the Bible people talk of having visions of God. How does science explain these?

Brain science is a very underdeveloped science, there’s no question about that. And like many such sciences it’s very overconfident. Genetics has been going through the exact same process. Charles Darwin came out with a great line once: “ignorance breeds confidence much more often than does knowledge.” So if you don’t know anything, it’s much easier to be utterly confident about what you are finding. Science of the brain is

Was the composer Saint Hildegard of Bingen receiving visions from God or suffering from a migraine?



still in a phase of being entranced by all these machines that go ‘ping’ – all these images and so on. Whereas in truth they probably don’t know very much.

But brain science can do quite well at explaining visions and hallucinations and schizophrenia. And it’s hard to deny the temptation to describe at least some of the visions of the saints in terms of mental disorder. The example I use a lot is the 13th Century composer Saint Hildegard of Bingen. She was a mystic who drew visions in a notebook. The suggestion is that they were migraine visions. If you have a migraine you see spinning, pulsing, throbbing, jagged images and it would be easy to see in that a divine visitation.

What about miracles such as the parting of the Red Sea and turning water into wine?

Well, I tend to walk away from that...

There have been cases where the wind has blown and exposed the bottom of shallow lakes. There have been great floods; there have been plagues of locusts. All these things are true. But to me that’s not very satisfying because there is no real evidence there. I try to stand back from the problem a bit and say, okay, well people think they saw someone walking on water. I don’t say this in the book, but it could have been self-delusion or an optical illusion. The person in the water could have been standing on a plank for all we know. But because these are just one-off events, there is not much to be gained from speculating. So I try to look at the bigger questions.

What impression did the Bible leave on you when you were studying it for your book?

The first thing I was reminded of is that the Bible is a very long book and, in some places, extremely repetitive. It goes on about battles and families and tribes and that sort of stuff. The thing I found interesting was the contrast you find in the feel of the thing when you read it in the 1611 King James Version compared with the modern English translations. The *New English Bible*, for example, sounds like the instruction manual for a vacuum cleaner. It’s got no poetry in it whatsoever.

So, do you think there is some kind of higher power?

I don’t, no. If there were one, I would like to see some evidence. But I am not aware of any. ■

Steve Jones believes that even with genetic engineering we will be unable to live longer than 120



STEVE JONES is a geneticist, TV presenter and award-winning author. His works include *The Language Of The Genes* and *Darwin’s Ghost*

JOURNEY TO THE STARS

By Paul Sutherland

Paul Sutherland is space correspondent for *The Sun* newspaper

THROUGHOUT THE SPACE age, rockets have used chemical fuels to blast free of the Earth's surface. Only they could produce the enormous thrust needed to achieve escape velocity and lift heavy spacecraft free of the planet. Once in space, however, such fuels are costly and wasteful for the return in speed gained. So space scientists have developed, or are

investigating, fresh methods of propulsion. Some, like space lasers or the warp drive in *Star Trek*, remain science fiction. But the pull of the planets and the slow but steady acceleration from ion drive engines have shown their worth. Soon a NASA solar sail called Sunjammer will test yet another way to fly, harnessing winds from the Sun.

SOLAR SAIL

SUNJAMMER (ARTIST'S impression above), the biggest solar sail ever, is due to launch this year. It will unfurl in space from a canister the size of a washing machine to become an ultra-thin spacecraft 38m across. Named after an Arthur C Clarke story, Sunjammer will fly like a kite in the solar wind, pushed along by the same flowing stream of sunlight that drives comets' tails away into space. Sunjammer will actually fly towards the Sun, using control vanes to tack like a yacht as it demonstrates solar sail technology. It will also carry UK experiments to monitor space weather. Solar sails could be used to remove space junk from orbit, but sent on a deep space mission, the solar wind could accelerate such a spacecraft to phenomenal speeds.



A technician puts the finishing touches to New Horizons's heat shield

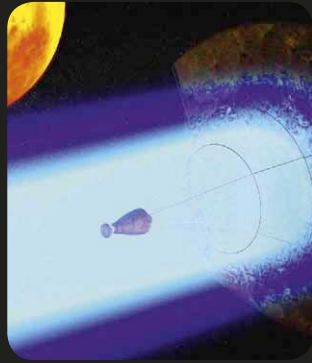
CHEMICAL ROCKETS

CONVENTIONAL LIQUID AND solid-fuelled stages have been used to lift spacecraft into orbit. The fastest probe ever fired into space was NASA's New Horizons, which was sent directly on a course for distant Pluto in 2006. A solid-fuelled rocket accelerated it to Solar System escape velocity, with just a little help from Jupiter's gravity to counter the Sun's own pull. It will reach Pluto in 2015.



LASER BEAMS

DIRECTING A REMOTE laser in orbit at a spacecraft could accelerate it through space, either by the pressure of photons or else by heating an on-board propellant to generate a jet of plasma. Such a thruster has been developed in the lab but not tested in space where 'Star Wars' tech is banned. The challenges are huge, not least how to avoid frying a probe's electronics.



NUCLEAR PROPULSION

THE IDEA OF nuclear-powered spacecraft, driven by the continual explosion of small bombs, has been considered since Project Orion in the 1950s but it is seen as a dirty fuel. A cleaner version, using nuclear fusion by detonating fuel pellets with a laser beam, is now mooted for a concept mission to the stars called Icarus. One snag is that no one has yet managed to harness fusion power.



The Icarus mission will take us to the stars, but first we need to master fusion power



ION PROPULSION

ION ENGINES USE electricity to charge a gas such as xenon in a magnetic chamber. Positively charged atoms are forced from the engine. The thrust achieved is far less than a chemical rocket, but over time will accelerate a spacecraft to 10 times the speed. Three ion engines now power Dawn (pictured) on its mission to asteroids Vesta and Ceres.

GRAVITY ASSIST

DEEP SPACE MISSIONS use the pull of the planets to help propel spacecraft. Instead of flying directly to a target, a probe will be slung around the Solar System to gain or lose momentum. NASA's Messenger probe could not have got to Mercury without Venus slowing it, while Voyager 1 (pictured) reached a record speed by fillips from Jupiter and Saturn.



WARP DRIVE

A SPACECRAFT WITH the speed of *Star Trek's* Enterprise remains science fiction, but experiments are being carried out at NASA's Johnson Space Center to see if a warp drive can become reality. Shrouded in secrecy, it involves creating a force called negative energy to make a distortion in space-time. A spaceship would ride this like a wave, enabling it to reach stars in days rather than centuries. ■

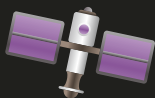


FAST, FASTER, FASTEST

Maximum or potential speeds (not to scale)



CHEMICAL ROCKET
58,000 km/h



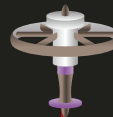
GRAVITY ASSIST
62,000 km/h



ION PROPULSION
320,000 km/h



SOLAR SAIL
325,000 km/h



LASER BEAM
2 million km/h



NUCLEAR
131,670,000 km/h
(12.2% of the speed of light)



WARP DRIVE
faster than light

HOW TO WIN THE

TOUR DE

The real rivals to the competitors in the ultimate cycle race are the laws of physics

Words: James Witts



FRANCE



SATURDAY 29 JUNE will see the world's most prestigious cycle race, the Tour de France, start from the island of Corsica. It will be the 100th race in the Tour's history. Once the race gets underway, the headlines will be dominated by the battle between the leading protagonists such as Chris Froome, Mark Cavendish and Vincenzo Nibali. But behind the headlines will be a battle to master the laws of physics. The rider declared the winner in Paris on 21 July some 3,360km (2,088 miles) after 'Le Grand Depart' in Corsica will be the one who most successfully maximises the positive force they use to propel their bike forwards while minimising the plethora of negative forces that slow them down.



➔ When the 180 cyclists set off from Porto-Vecchio in southern Corsica bound for Bastia at the island's northern tip 212km (131 miles) away – the first stage of the race – it will be their first encounter with the forces that counter the propulsive thrust they exert through the pedals. Gravity, air resistance, rolling resistance and friction (see 'A battle of physics' below) all act to sap energy and slow progress.

By the time they're in the saddle at the start of the race, there's nothing the riders can do to minimise several of these forces. It's all in the preparation. Take rolling resistance – the force resisting the forward motion of the tyres when they roll over the road surface. The combined weight of the bike and rider causes the tyre to deform on contact. The tyre doesn't spring back with the same energy that deformed it, so some of the energy is lost as heat. Studies show that up to about 14km/h (9mph), rolling resistance accounts for about 50 per cent of drag.

To counter rolling resistance, professional riders use tubular wheels rather than clinchers. Unlike clinchers, where the tyre and inner-tube combination sit clinched in the rim of a wheel, tubular

wheels dispense with the rim and two-piece combo. Instead, they use a one-piece tyre that glues onto the wheel. Because of the lack of rim enveloping the side of the tyre, you can inflate it to a higher pressure than with clinchers – to about 120psi for Tour riders on a road stage like Porto-Vecchio to Bastia, though the front wheel tends to be 10psi less for better handling. This minimises the tyre's deformation and

therefore rolling resistance. A typical road car has a tyre pressure of around 30psi.

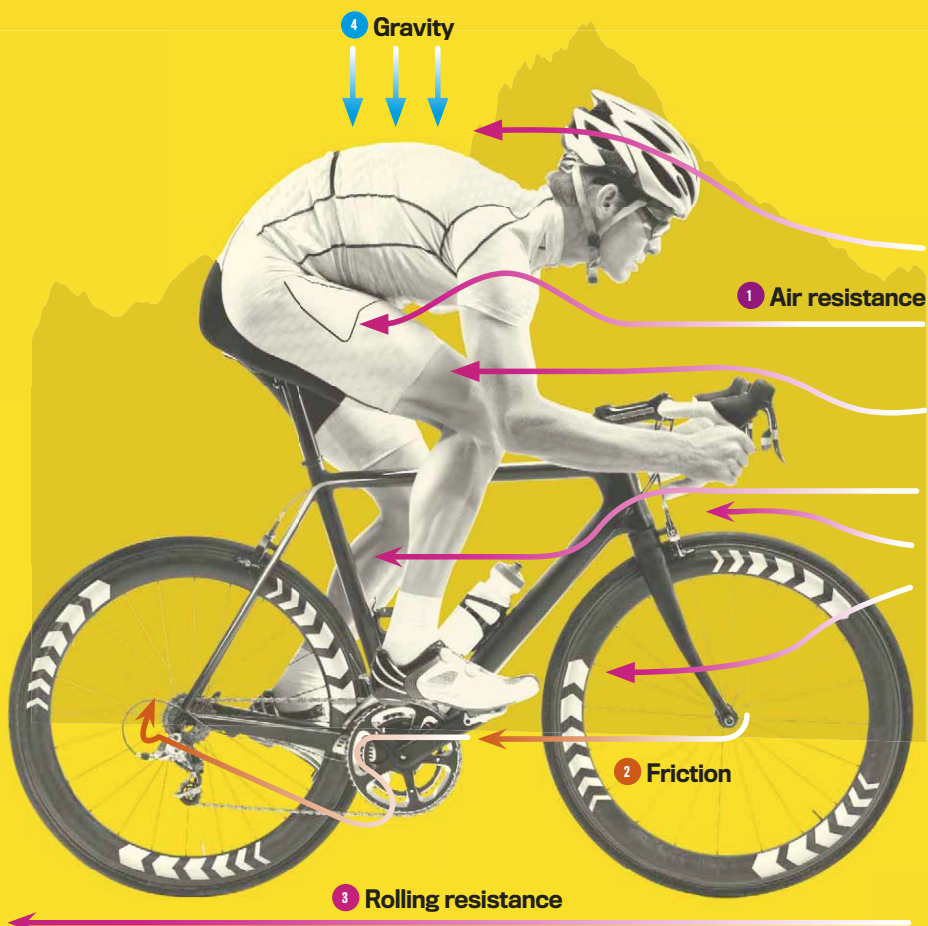
The same goes for energy lost through friction in the moving parts of the bike – it's beyond the rider's control. But friction has been minimised by bike designers through the years. "The drivetrain such as the chain and cranks – provided you keep it oiled and dust-free – is 98.5 per cent efficient," says Graeme Obree, former



A BATTLE OF PHYSICS

The key forces cyclists will have to contend with in the 3,360km race

- 1 Air resistance:** Riders must push air aside to move forward. Above about 14km/h (9mph), it is the most significant force hindering progress. To be precise, $\text{air resistance} = 0.5 \times \text{air density} \times \text{cycling speed (in still air)}^2 \times \text{the drag coefficient of the rider and bike} \times \text{the frontal area of the rider and bike}$.
- 2 Friction:** This is a force for good and bad. Without it, your tyre wouldn't grip the road and you'd go nowhere. But friction in the drivetrain – essentially the bike's moving parts – can lose about 3 per cent of energy.
- 3 Rolling resistance:** The combined weight of rider and bike misshapes the tyre, losing energy because it doesn't spring back with the same energy that deformed it.
- 4 Gravity:** This force keeps riders firmly on the ground, but the pull of the Earth is also what makes climbing the likes of Alpe d'Huez such a struggle.





Advanced tubular wheels like these reduce the amount of rolling resistance experienced by riders

holder of the one-hour velodrome track record who gained fame for breaking the record in 1993 and 1994 on a bike that comprised parts of a washing machine.

THE TOUGHEST FOE

But rolling resistance and mechanical friction have a minimal impact compared to air pressure. In Corsica, at an average temperature of 26°C for late June and around sea level, a cubic metre of dry air will have a mass of about 1.2kg. Air pressure creates a force proportional to the square of the rider's speed. But the power to push the cyclist through the air increases as the cube of velocity. So going twice as fast requires eight times the power. Tour riders will expend 90

“Tour riders will expend 90 per cent of their energy overcoming air pressure as they hit speeds of 54km/h”

per cent of their energy overcoming air pressure as they hit speeds beyond 54km/h (34mph). That is, of course, unless they're sitting within the confines of a 'peloton' – a pack of riders.

“Riders leave a significant wake behind them,” says Dr Rob Lewis of TotalSim, experts in the field of computational fluid dynamics who have worked with British Cycling. “This wake is effectively air that has been dragged along with them and is moving forwards. So when a following rider is close and in this wake, it's as if someone has turned the headwind down.” Those gains are significant, with research showing that at 55km/h (34mph), a trailing rider will use 35 per cent less effort.

The exploits of Dutch cyclist Fred Rompelberg in 1995 highlight the impact of drafting. On the Salt Flats of Utah, he pedalled to a record 268.83km/h (167mph) by following a dragster with an extra large fairing at its rear. It's an extreme example, but one that provides a lesson for cyclists in the Tour de France, says Obree: “Ideally the smaller rider has a bigger rider in front of him, as they'll act like a windshield.”

One of the smaller riders in the Tour will be Mark



PHYSICS OF THE TIME TRIAL

When it's rider and machine against the clock, attention to detail is crucial

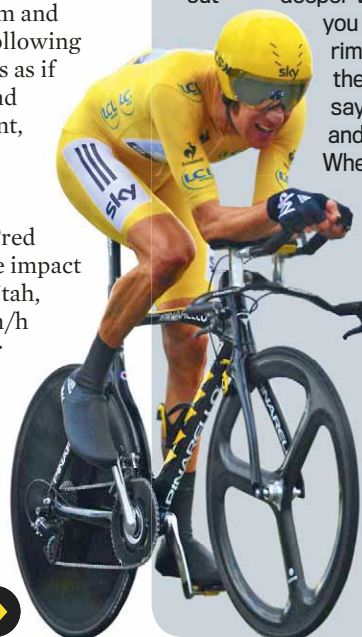
In the Tour de France's time trials individual riders or teams start on their own and race against the clock. In both cases riders use a specialist bike, the geometry of which stretches the rider further along the 'aerobars' for a more streamlined position. “The theory is simple,” says aerodynamicist Simon Smart, who runs Smart Aero Technology. “Basically, the rider's frontal area is reduced, so air resistance drops.”

Making fine adjustments to riding position in a wind tunnel can make all the difference. “For someone who hasn't refined their position in the tunnel, a 10 or 15 per cent reduction in drag is easily achievable,” says Smart. Even hand position affects your slippiness through the air. Wind tunnel data suggests an ‘arrow grip’ on the bars, with the tips of the fingers touching, gives a 0.54 second saving for every minute ridden at 35mph compared to an athlete using the traditional thumbs-inside aerobar grip.

It's in the time trials that wheel design is at its most extreme, with some riders employing spoke-free disc wheels. They act as a fairing, smoothing out the airflow from the tyre and reducing drag. The lack of drag-producing spokes compliments this further.

Even on a standard flat stage of the Tour, riders use pretty hefty rims to reduce drag. But windy conditions rule out deeper wheel rims. “Let's say you have a 30mm deep rim and you're right on the wheel in front of you,” says Paul Lew, designer and founder of Reynolds Wheels. “And then maybe the situation changes – a small gap opens up, the wind changes – you go round a turn and all of a sudden that air hits your wheel. Now if you're riding a 30mm, you don't feel it very much. But if you're riding a 50mm wheel you can lose control.”

Even Bradley Wiggins's hands are positioned to be aerodynamic



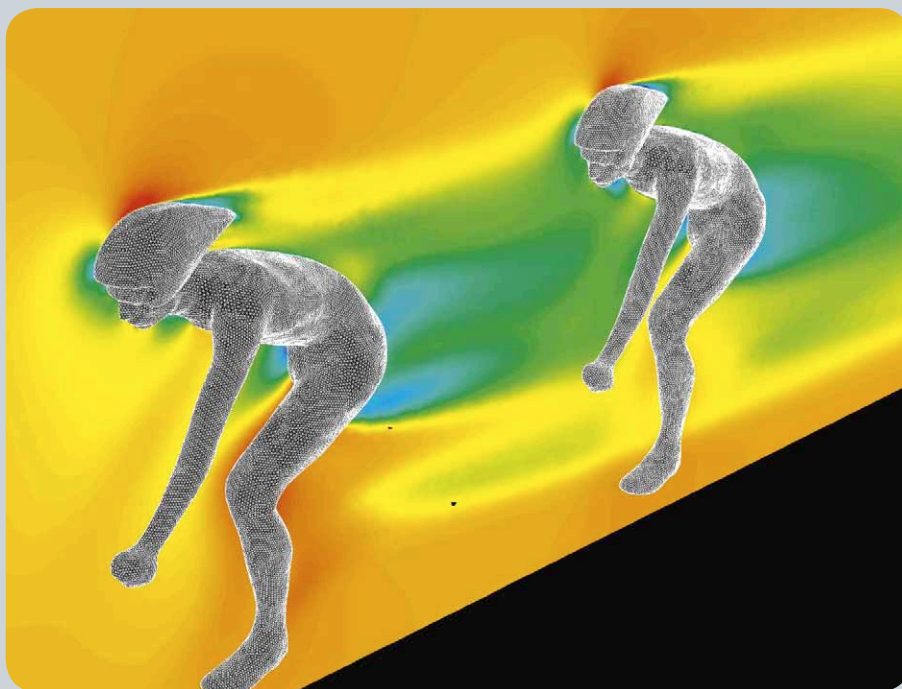
THE WIND TUNNEL INSIDE A COMPUTER

How computational fluid dynamics is shaping race tactics

The science of computational fluid dynamics (CFD) is reshaping bikes and changing the tactics used by riders. It allows the effects of airflow on bike and rider to be calculated using numerical analysis and algorithms.

Professor Bert Blocken and his team at Eindhoven University of Technology in the Netherlands recently used CFD to analyse the influence of drafting (where one rider sits closely behind another) on airflow with some interesting results. "Our analysis showed that six to eight riders in a pack is optimum with each sat about 0.01m from the next wheel," says Blocken. "The reason is that the wake – formed as airflow passes an object – keeps widening until peaking at the sixth rider." Above six riders, the pack can become unwieldy and lose its optimum drafting distance.

Admittedly the results could be unrealistic on the road because each rider in the model is just 0.01m behind the next rider's wheel. "But it could be used in a velodrome time-trial," says Blocken. "And even on the road, riders will arrange themselves in a staggered fashion beside each other, which could lead to even greater reductions in drag."



This computational fluid dynamics image shows how rider position impacts upon air velocity. A lower air velocity, the green and blue areas here, means lower forces acting on a rider. So the benefits of drafting for the second rider are clear.

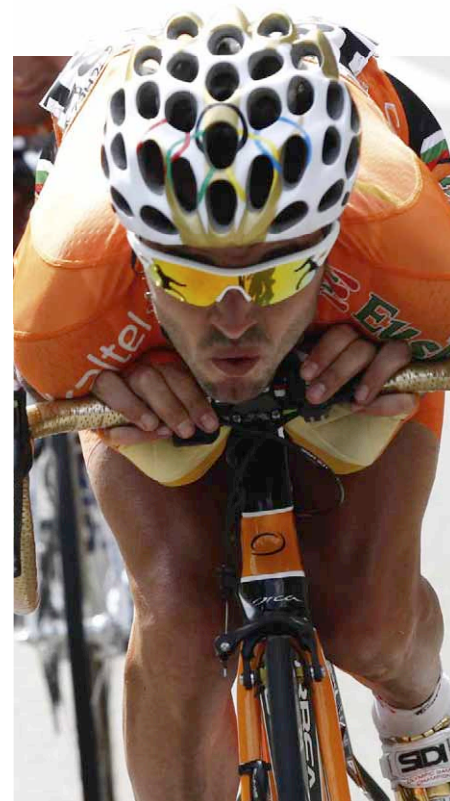
➔ Cavendish. At 5ft 9in tall, he will sit behind his team of 'domestiques' – supporting riders in his team – throughout most of the stage to conserve energy for his devastating sprints at the end.

But it's in these frantic last few metres of a day's race that the 'Manx Missile' – who at 70kg is far from being the bulkiest of professional riders – defies the physics stacked against him. "A heavier rider will generally produce more power," says Simon Smart, a former Formula One aerodynamicist who switched to cycling, founding Smart Aero Technology. It's a

point elaborated on by Obree: "Big riders have an advantage over smaller riders because the amount of power you produce is related to the volume of your body. Volume increases cubically but frontal area increases to the square." In other words, as the bulk of a rider increases, the power increases more rapidly than air resistance. But tactical acumen, an aerodynamic position and an incredible 1,600 watts of power will ensure Cavendish is in contention in the sprint in Bastia and many of the other sprints in the Tour.

CLIMBING PHYSICS

Unlike that first day in Corsica, many of the stages, including the 168km (104 mile) stage 18 from Gap to Alpe d'Huez in the heart of the French Alps, involve steep climbs. Now the balance of time-sapping forces shifts. "In climbing, cycling speed is generally low," says Professor Bert Blocken at Eindhoven University of Technology in the Netherlands. "You will therefore often see that cyclists have their hands on top of the handlebar and are sitting quite exposed to the airflow. This is because power output and weight



Spain's Samuel Sanchez makes himself as aerodynamic as possible in the 15th stage of the 2010 Tour de France

"It's in these frantic last few metres of a day's race that the 'Manx Missile' defies the physics stacked against him"

is more important than aerodynamic resistance here.”

On the flat, gravity simply ensures the bike stays in contact with the road. On an incline, Earth’s pull assumes a new significance. “It is proportional to the mass of the rider and bike and the gradient of the hill,” says Smart.

It’s in the climbs that a rider’s power-to-weight ratio becomes particularly important. Take last year’s green jersey winner – the best sprinter on the Tour – Peter Sagan, and polka dot jersey winner Thomas Voeckler – the best climber on the Tour. Sagan weighs about 74kg, Voeckler 66kg. Say Sagan’s maximum sustainable power output is 400 watts compared to Voeckler’s 380. On the flat, Sagan will have an advantage but when gravity comes into it, it’s power-to-weight that’s important. Sagan would deliver 5.4 watts per kg compared to Voeckler’s 5.8.

As well as the weight of the riders, the weight of their equipment plays a role in this power-to-weight ratio. The statistics for Bradley Wiggins’s 2012 Tour show the huge strides made here. He weighed 71.1kg, whereas his carbon-forged bike came in at just 7kg and his clothing, shoes and helmet added only a further 1kg.

MENTAL FORCE

Once the riders reach the summit of a climb, it’s time to let gravity play a more positive role during the descent. “This is where lighter riders have a disadvantage,” says Obree. “Heavier riders can take greater advantage of that downward force, which eclipses a slight increase in air resistance on the bigger rider.” But the true decelerating force on a descent? “That’s fear,” says Obree. “I know it’s not really a force but it feels like it when you’re hitting speeds of 70km/h going round a corner.”

At higher speeds, minimising air resistance is also key. Riders assume a tucked position and the aerodynamics of the cycle takes on a particular significance. “The difference between round tubing and streamlined tubing goes back to the 1950s,” says TotalSim’s Dr Rob Lewis. “Ascher Shapiro [a professor of mechanical engineering at MIT] showed that airflow is far more turbulent passing around round objects compared to a smooth airfoil. It’s why brake cables aren’t as insignificant as they look.” Many manufacturers now integrate the cables within the frame.

Road bikes feature frames with an aerodynamic shape that is very close to the rear wheel. This smooths out the turbulence of the air being chucked out from the back. And the forks which clamp

RACING BIKES OF THE FUTURE

How plasma aerodynamics and mind-controlled gears would transform races



Graeme Obree on his innovative recumbent bike the Beastie

Wind-tunnels, carbon layers, teardrop-shaped helmets – on the surface, biking technology is at the cutting-edge of innovation. However, delve a little deeper and that’s not the case. “UCI [cycling’s international governing body] regulations mean bike design has remained static for 10 years,” says Obree.

The UCI has strict guidelines for races regarding aerodynamic developments. Obree is currently refining his project to break the human-powered land-speed record on his recumbent bike, the Beastie – the record doesn’t sit beneath UCI regulations. “If you threw the rulebook out the window, you’d be lying down backwards or facing forwards. It’s much more aerodynamic,” he says. Obree will have to go some – the current record is 133.27km/h (82.81mph) held by Canadian Sam Whittingham.

But if that rulebook flew out the window, what would we see? In the Cold

War, Russian researchers discovered that injecting ions – atoms and molecules with a charge – into the air-flow around high-speed craft reduces drag. A development of this technology could see bicycles and bike clothing embedded with a mesh of plasma generators. An AC voltage would be sent down the mesh, exerting a force on the ambient air and altering the airflow. A figure of 50 watts saving has been mooted.

But cycling could become even more futuristic. In 2011 Toyota linked up with Parlee bikes and human/digital interface specialist Deeplocal to build a mind-controlled gearbox. A ‘neurone helmet’ picks up electrical signals from the brain that are sent to an electronic gear system beneath the saddle. Still a prototype, riding with no hands could soon be here.

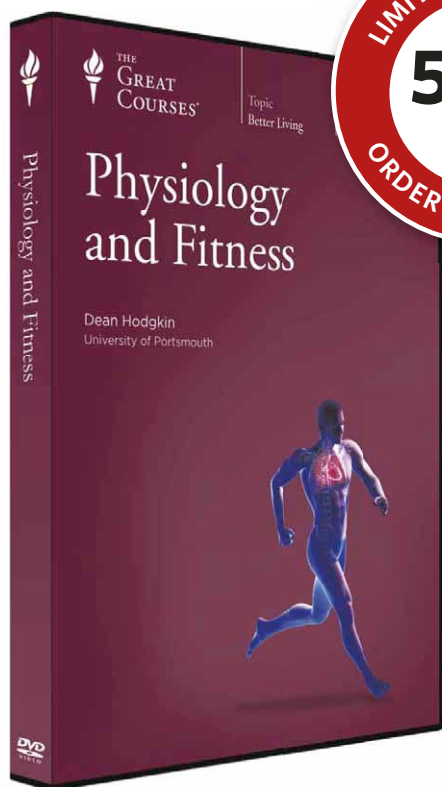
According to Obree, however, the greatest future advancement is a simple one. “Attach a fairing similar to a moped at the front of your bike, and you’d go 20 per cent quicker.”

onto the front wheel are very narrow – as thin as 6mm – which cuts frontal area and, it has been reported, can save up to 41 seconds over a 40km time trial – another part of the race where optimising aerodynamics is crucial (see ‘Physics of the time trial,’ on p75).

The Tour is a race where seemingly tiny changes – not only to the equipment but also to training regimes and race tactics – determine who is standing on

the podium at the end of each day. British Cycling calls these subtle tweaks ‘marginal gains’. To the likes of Chris Froome and Mark Cavendish, this will mean a slight advantage over the likes of Vincenzo Nibali. But ultimately, it is marginal gains over the real foe – the laws of physics. ■

JAMES WITTS is a sports journalist with a degree in sports science



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THE FUTURE OF GADGETS

TECH HUB

THIS MONTH

BILL THOMPSON
Cries into his phone
p81

JUST LANDED
Next-gen sat-nav
p82

ULTIMATE TEST
Cameras vs phones
p85

EDITED BY **DANIEL BENNETT**

Video just got a lot more immersive thanks to a prototype technology from the BBC



ON THE HORIZON

BBC SURROUND VIDEO

THE NAME MAY be a little plain, but BBC Surround Video will make your TV viewing experience a great deal fancier than it is now. It's a system that extends the image beyond the borders of your screen and into the rest of your living room – like surround sound for your eyes.

"We wanted to think of a way to make television more immersive," says Graham

Thomas, who heads up BBC R&D's Immersive and Interactive Content team. "With audio, you can upgrade from stereo to 5.1 and put speakers all around your living room, but there's really nothing you can do for video except buy a much bigger display, and that can get horribly expensive."

Not to mention logistically tricky – we don't all have front rooms big enough for an 84-inch telly. Thomas and his

team reasoned that you might be able, instead, to seamlessly extend what was on an existing TV screen using a projector and the walls of the room. Because the projected image will only be seen in peripheral vision, it doesn't need to be particularly bright or sharp, so there's no need to mount screens, or even paint the walls white.

BBC R&D swiftly built a working prototype in its lab. The technology is



Two cameras mounted side-by-side, one with a fish-eye lens, capture the video content



divided into two parts: the capture technology and the replay technology. For capture, two cameras are used: one has a normal field of view, and bolted next to it is a fish-eye lens camera that captures a 180-degree field of view. This two-camera rig is then used to film footage.

For replay, the main camera footage is played back on a normal flatscreen TV, while the fish-eye footage is projected onto the walls all around the viewer. A wide-angle projector is required for this, but to save money (such projectors start at around £10,000) the researchers used a cheap home projector teamed with a £75 curved mirror of the kind used in shop security systems. Some clever image processing software is then used to line up the two images.

The effect is impressive, drawing you into the TV picture by putting motion and colour in your peripheral vision. "Material where there's movement works well, particularly shots from cars or trains – you get a real sense of presence moving through space," says Thomas. "But if there's something important going on in

the periphery, you can't assume viewers are going to see it. So the important action still has to take place on the TV screen."

It's easy to see how Surround Video might have applications in gaming, where the goal is to suck the player into other worlds. Indeed, Microsoft's Illumiroom concept, designed to work with the Xbox, is very similar. But as with the BBC's technology there's no roadmap for a commercial release – it's a case of keeping our fingers crossed and hoping someone develops the idea further. Nonetheless, Thomas feels such technologies could become fairly widespread within 10 years.

"I wouldn't say they'll become the norm, because many people like having the TV on in the corner of the room and just letting it sit there," he says. "But there are always enthusiasts who'll build themselves home cinema systems using the latest available technology, so there will certainly be at least a niche market for this."

SAM KIELDSEN is a freelance technology journalist based in New York

TECHOMETER

Google

WHAT'S HOT

GOOGLE

The search giant's stock recently soared to over \$900 a share. The upsurge was no doubt driven in part by all the fuss about Google Glass, but also by a host of recently announced new Google services and features. These include the launch of Spotify rival Music All Access, the ability to send money via Gmail using Google Wallet and new, improved personalisation for Maps and search.

WHAT'S NOT

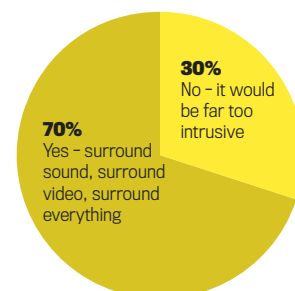
BLACKBERRY PLAYBOOK

Blackberry recently refused to confirm whether or not the upgrade of its tablet device to the Blackberry 10 operating system – promised over a year ago – was still going ahead. Playbook has sold poorly since its launch in 2011 and is currently on sale in the UK at greatly discounted prices, suggesting that Blackberry may have to change its approach to tablets.



READER POLL

Would you watch surround video?





EARLY ADOPTER BILL THOMPSON

How does that make you feel, Dave?

Trying to write on the early train to London always makes me irritable.

At least I think it does. I'm feeling irritable now, for instance, and I'm writing this on the 08:15. But it might not really be the train that's the problem.

It might be because it's Tuesday, or because it's raining, or because I had Weetabix for breakfast. If I knew what was behind my irritation, I might be able to do something about it – have Shredded Wheat, or drink less coffee, or start doing yoga in the mornings.

Help is at hand from my smartphone, which can offer a range of apps and services to help me track my mood and see whether there are any useful correlations. Because even though our smartphones aren't especially smart, and some of them don't even make very good phones, they are packed with sensors and can be used to record all sorts of data.

One of the most sophisticated mood-tracking apps is currently the focus of a research project in the Computing Lab at Cambridge University, somewhere that's dear to my heart as I studied there many years ago. A research associate, Neal Lathia, has combined his interests in data mining, mobile systems

and recommendation systems to build Emotion Sense, currently available for Android devices.

Like other emotion-tracking apps such as MyMoodTracker and EmoCube, Emotion Sense asks you to tell it how you're feeling using a grid of awake/sleepy and negative/positive, and correlates this with the data it gathers from other sources, including your



location, movement and patterns of communication.

The privacy implications are huge, since in order to offer feedback the software needs access to all of your phone's sensors and traffic data. This information, such as when you make and receive calls, is the sort of stuff that the government is keen on having telecoms keep for a couple of years so they can trawl through it if they want to. But the model is a powerful one. It reminds me of the system my father uses to monitor

his blood pressure and heart function from home. The data is collated and sent to his GP every day, and if they notice anything unusual they call him in, instead of relying on regular check-ups, most of which are unnecessary.

The idea that mental health and physical well-being are not separate but simply different aspects of our lives is slowly becoming more widely accepted. So if we can better understand the good and bad things that fill our days we might be more able to help people who are suffering, however that suffering is expressed.

Tracking your moods with a smartphone isn't going to change anything by itself (though no doubt there'll be a wave of apps offering therapy and counselling before long). But our assumptions about how mood correlates with behaviour are often inaccurate. By replacing them with some well-sourced data, our understanding of how we feel could be put on a more scientific basis.

I've been logging my physical activity for a while now – logging my emotional life seems like a reasonable next step.

Bill Thompson contributes to news.bbc.co.uk and the BBC World Service

COMING SOON

3 MONTHS

FAIRPHONE

If you like your coffee 'fair trade' and your paper recycled, then you might need to reconsider your smartphone choice. The Fairphone will use recyclable materials and sustainable resources where possible, while working with factories that meet their ethical standards. Fairphone.com



+ **Ouya** A £99 cloud-based console that aims to make gaming more affordable. At launch the prices will be akin to what you're used to on your smartphone. Ouya.com

+ **Intel Haswell** Intel says its latest lightweight chip systems are so power efficient they'll double current the battery life of future tablets and laptops. Intel.com

6 MONTHS

XBOX ONE

Microsoft's new toy will ship with an upgraded Kinect sensor that can monitor your heart rate, the ability to tune-in to live TV and multi-tasking, so you can switch between Skype and your game at the press of a button. Controversially, secondhand games are rumoured to require an added 'activation fee' in order to function. Xbox.com



+ **PS4** Gaming goes social with Sony's new Facebook-connected console. You'll be able to share high scores and killer moves at the push of a button. Playstation.com

+ **Scanadu** This isn't quite as clever as *Star Trek's* tricorder, but it is the most sensitive personal medical sensor to date. It'll measure your temperature, heart rate, oxygen levels and much more. Scanadu.com

9 MONTHS

ADIDAS MICOACH SMARTBALL

This smartball records every kick's strike zone, power, spin and trajectory and transmits it to a smartphone app before offering advice on how to improve. Someone ought to get one of these to the England football team. Micoach.adidas.com



+ **Google Glass** Engineers are tweaking the design of Google's augmented reality specs after thorough testing with the aim of releasing a device in 2014. Google.com/glass

+ **Xi3 Piston** A PC that will fit in the palm of your hand, yet offer better graphics than the current generation of consoles. Xi3.com



TELL US WHAT YOU THINK!

Are you ready to share your emotions with your phone – and with app developers? Give us your opinion by emailing reply@sciencefocus.com



JUST LANDED

THE HUMAN SAT-NAV

A breakthrough in spoken directions means Garmin's new flagship sat-nav will talk to you like a real person. Gordon Kelly puts some miles on the clock

What is it?

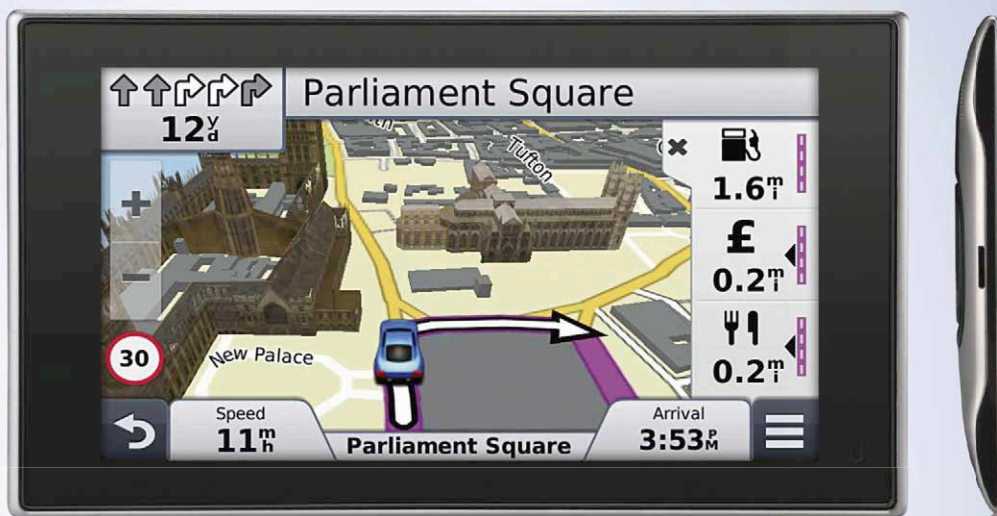
Its rather lengthy name is the nüvi 2598LMT-D, but what it does is far more memorable. Unlike any sat-nav before it, the 2598LMT-D gives directions in easily digestible human terms. This means robotic instructions like 'In 300 yards, turn left' are replaced by 'In 300 yards, turn left after the petrol station' or 'In 300 yards, turn right at the traffic lights'.

Garmin calls these 'Real Directions'. It achieved them by contextualising directions with the millions of POIs (points of interest) in its database. They include landmarks, buildings, traffic lights and junctions, plus big name businesses such as coffee chains, department stores, banks and chemists.

Why would I want one?

The most significant benefit is safety. When given obvious points of reference to the world around you, the need to guesstimate distances is greatly reduced. Consequently you spend less time looking at the sat-nav and more time concentrating on the road.

That said, the nüvi 2598LMT-D is far from a one-trick pony. Owners also get free lifetime map updates and free real-time traffic updates. The latter sees



faster routes calculated automatically should an incident occur on your current course. And Bluetooth connectivity enables the 2598LMT-D to pair with your smartphone to make and receive hands-free calls.

To add some visual flair this is also Garmin's thinnest ever sat-nav, with an aluminium finish and a five-inch, high-resolution glass touchscreen.

The nüvi has a magnetic back that enables it to snap to its stand for ease of use



One nice design touch is the magnetic mount, which allows it to be snapped in and out of its holder more quickly.

How useful is it?

We took the 2598LMT-D for a drive through central London and were highly impressed. The crowded streets and numerous junctions usually make it hard to keep track of basic distance-based instructions, but with the added geographical context we didn't miss a turn. With a constant flurry of people and traffic around us, being able to look ahead and concentrate on the road made the route far more relaxing.

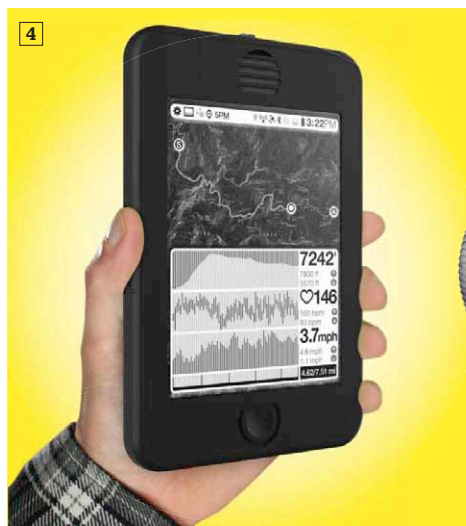
The 2598LMT-D also delivers excellent battery life, lasting over six hours on a single charge.

Should I buy one?

With any new technology, the first gadgets are often costly, but the 2598LMT-D is reasonably priced at £199. Real Directions will also feature in all new Garmin models, with entry level prices starting at £139. Garmin freely admits that sales of its sat-nav hardware have been hurt by ever more powerful smartphone apps that do the same job. But for now at least, the company has a powerful new differentiator.

GORDON KELLY is a freelance technology journalist

NÜVI 2598LMT-D, £199
WWW.GARMIN.COM



APPLIANCES OF SCIENCE

1 REACHING OUT

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2 FIRE UP YOUR PHONE

Whether you're getting away from it all in the back of beyond or getting down and dirty at a festival, campsites and phone chargers don't make great bedfellows. Voto solves that by generating electricity from the heat of your barbecue or campfire. Charge the Voto as you cook, then charge your phone, tablet or any other device from the Voto afterwards. It doubles as a torch, too. **Point Source Power Voto** pointsourcepower.com, price TBC

3 BREATHE EASY

Do you worry about how much CO₂ is in the air inside your house? Worry no more with this discreet monitor, which links to your iOS or Android device and gives you data on humidity, temperature, air quality, CO₂ levels and 'acoustic comfort'. A second, outdoor monitor enables you to keep an eye on barometric pressure and produce seven-day weather forecasts for your exact location. **NetAtmo Urban Weather Station** netatmo.com, £139.95

4 MY NAME IS EARL

This water, dust, shock and mud-proof Android tablet is designed to go just about anywhere in safety. As well as running the full range of Android apps, Earl has a solar charging panel, a flexible E-ink screen and a built-in multi-band two-way radio. Plus, there's GPS to stop you getting lost and wind, temperature, humidity and pressure sensors to help you avoid treacherous weather. **Earl BackCountry Survival Tablet** meetearl.com, from \$249 plus P&P

5 DOUBLE VISION

Perfect for naturalists and birdwatchers, these new digital recording binoculars not only offer up to 12x optical and 25x digital magnification, they'll also record everything you see while you're using them. They can capture 20.4-megapixel still images, or record high-resolution MPEG-4 video - even in 3D. Weighing in at just 765g, they're GPS-enabled so that all your photos and videos can be geotagged. **Sony DEV-50V** sony.co.uk, £1,749

6 JUICE-FREE LUCI

No more weighing down your camping kit with batteries! This lantern features 10 LED lights inside an inflatable, waterproof enclosure. It runs off a lithium ion battery that's recharged by solar panels, and will provide up to 12 hours of light at 80 lumens off a single charge. What's more, thanks to a 'Buy One, Give One' scheme, for every lantern sold another will be sent to developing countries. **Luci** mpowerd.com, \$14.95 plus P&P (or £19.99 from Firebox.com)

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SCIENCE OF HEALTHY LIVING

ULTIMATE TEST

CLASH OF THE CAMERAS

Should you take a camera on holiday with you this summer, or will your smartphone do? **Daniel Bennett** pits the latest smart snappers against the iPhone 5

EVERY DAY, 300 million photos are uploaded to Facebook. Most of these are snapped with a phone, not a camera. You can see why: most smartphones offer an eight-megapixel camera, photo editing apps and instant sharing via social networks or email. Plus there's GPS tagging and Full HD video, and they're usually smaller, too. So when it comes to your summer holidays, should you be packing a camera or will your smartphone suffice?

Will the likes of Apple's iPhone, Samsung's Galaxy and Google's Nexus make the compact camera obsolete?

To find out, we took the latest pocket cameras from Samsung, Fujii and Olympus and set them against the iPhone 5 to represent smartphones in general. We compared design, usability, features and most important of all picture quality, to see whether it would convince us to leave our camera at home. →



PHOTO: THESECRESTUDIO.NET



Size: 124x59x8mm **Weight:** 112g **Sensor:** 8-megapixel
Screen: 4-inch **Optical zoom:** None **Extras:** 3G, Wi-Fi

IPHONE 5

apple.com, £529 (SIM-free)

➔ IN BROAD DAYLIGHT the iPhone 5 can snap some spectacular shots. Bright colours – flowers in bloom and rolling green hills – are accurately reproduced and tapping on different parts of the screen will shift the picture's focus. The iPhone is at its most useful, though, when you need to snap a shot quickly. Whip it out of your pocket, tap the home button twice and the camera loads up almost instantly. Its smart auto-focus will pick up faces and you can capture the moment while other cameras are still warming up.

But like most smartphones, the iPhone struggles in anything but the best light conditions, which in the real world means much of the time. Photos taken indoors or at sunset can be grainy, while differences in light intensity will turn figures into silhouettes. The HDR setting, which takes several pictures at once at different exposures and combines them, can help, but there are limits to its

abilities. Ultimately, the phone's image sensor isn't responsive enough to accurately capture the subtleties of light in a dim room.

The iPhone's chief strength is access to photo editing apps that let you tweak your images. Snapseed, for example, offers almost pro-level editing behind intuitive touch controls, while for panoramic photos the iPhone's own software is unrivalled. The phone's built-in GPS will tag every pic's location and drop them onto a map when you get back, and all this is wrapped up in Apple's intuitive iOS operating system. If you want smart features and fun in a camera then a smartphone's hard to beat.

Ease of use ■■■■■
 Build/design ■■■■■
 Features ■■■■■
 Picture quality ■■■■■

VERDICT ■■■■■



Size: 117x70x57mm **Weight:** 353g **Sensor:** 12-megapixel
Screen: 2.8-inch **Optical zoom:** 4x **Extras:** Optical viewfinder

FUJIFILM X20

fujifilm.eu, £499

THE X20 MIGHT look like it's beamed in from the '80s but it's packed full of the latest imaging technology. The metal casing is sturdy, a cut above most plastic compacts, and the 12-megapixel sensor inside is incredibly smart. When we took pictures in a forest, it picked out the delicate shafts of light lancing through the leafy canopy and the colour accuracy and depth was like few compacts we'd tested. Pictures taken at dusk were superbly detailed, too, without any of the graininess or blurring of smartphone snaps.

The autofocus is quick, picking out the details you want to focus on and adapting the camera's settings in split seconds. In fact, you'll rarely need to venture beyond the excellent Advanced Auto mode, but for confident photographers any adjustments are quick to make with the camera's simply laid-out wheels and buttons. The manual zoom only offers 4x magnification, though, which is of limited use.

Unlike the other cameras on test there's also a viewfinder, which can help when framing your shots and means you don't need to wait for the screen to fire up. Digital filters simulate different types of vintage film, though it's nothing like what's on offer in the Samsung Galaxy and iPhone.

This camera's impeccable quality and retro styling make it a delight to use. Within days you'll become attached to it – a rare feat for a piece of technology. It's a reminder of why smartphones still have some way to go to replace the compact. The RRP of £499 might scare off most, but if it's within your budget this is a purchase you're unlikely to regret.

Ease of use ■■■■■
 Build/design ■■■■■
 Features ■■■■■
 Picture quality ■■■■■

VERDICT ■■■■■



Size: 129x71x19mm **Weight:** 303g **Sensor:** 16.3-megapixel
Screen: 5-inch **Optical zoom:** 21x **Extras:** Wi-Fi (3G model available)

SAMSUNG GALAXY CAMERA

Samsung.com, £349 (Wi-Fi model)

WITH NO BUTTONS in sight and a large 4.8-inch touchscreen – all the better for seeing your pictures with – the back of this camera could easily be mistaken for a smartphone. The similarities extend beyond the screen, too. The Galaxy Camera runs on the Android operating system, with all the apps that come with it. Like a smartphone it will upload your photos at the touch of a finger (when you have a Wi-Fi connection), show you where they were taken or edit them with apps like Snapseed and Instagram.

From the front, however, there's no mistaking this for a phone. The 16.3-megapixel sensor is attached to a telescopic lens that can magnify an image up to 21 times – perfect for snapping wildlife from afar. Quick shots come out great, but it's in the smart features that the Galaxy's strengths really lie. Options like Best Face and Best Photo take a quick burst of shots so you can select the top shot out of six, avoiding anyone who's

gurning, while modes like Sunset, Waterfall and Night really do adjust the settings to achieve the best shots. Novice photographers who want to learn more can tinker with advanced settings that let you change the shutter speed, aperture and white balance while showing you on-screen how it will affect your shot.

On the downside, all these features make the camera heavy, and keen photographers will miss the buttons and dials that let you sift through settings quicker than a touchscreen allows. But if you want the versatility of a smartphone paired with photos you can be proud of, then the Galaxy Camera is the one for you.

Ease of use ■■■■■
 Build/design ■■■■■
 Features ■■■■■
 Picture quality ■■■■■

VERDICT ■■■■■



Size: 111x66x29mm **Weight:** 230g **Sensor:** 12-megapixel
Screen: 3-inch **Optical zoom:** 4x **Extras:** GPS, shock/sand/waterproof

OLYMPUS TG-2

Olympus.co.uk, £329

SAND, SNOW AND seawater will trash your smartphone, which is where the tough Olympus comes in. It's built for adventurers, or just the clumsy – I count myself among the latter. It's airtight, so sand and water are no bother (up to a depth of 15m) and it's hardened to withstand the knocks and bumps of travelling. We can certainly attest to its toughness – it survived slipping through our fumbling fingers several times. If you prefer the piste to the pool then it's also resistant to cold temperatures that would cause lesser gadgets to seize up. There's built-in GPS, too, which will log where each photo was taken and can even lead you back there.

The camera takes wonderfully sharp pictures. The 12-megapixel sensor captures crisp shots in all types of light and even has a setting to pick out sparkling colours underwater. Though the image quality isn't quite on a par with the Galaxy or the Fuji, you'll be glad you brought this camera

with you, as I was, the minute you drop it in the sand. The mechanical zooms and buttons of the other devices on test would have been ruined.

Surprisingly, with all its padding the Olympus is still smaller than the other compacts on test. Plus there's a 4x optical zoom and built-in filters and effects. The only bad side-effect of its hardened shell is that its buttons and wheels are a bit stiff. That said, with all that this camera can offer, it arguably makes the best case for taking a camera on your travels as well as your smartphone.

DANIEL BENNETT is reviews editor of *Focus*

Ease of use ■■■■■
 Build/design ■■■■■
 Features ■■■■■
 Picture quality ■■■■■

VERDICT ■■■■■

THE MEANING OF EGYPTIAN HIEROGLYPHS

BY ANDREW ROBINSON

The ancient Egyptians' pictograms had archaeologists baffled, until some pioneering early 19th Century linguists deciphered them

T

HE DISCOVERY OF Tutankhamun's tomb wouldn't happen for another century but in 1821 in Piccadilly, London, an exhibition about ancient Egypt opened. Encouraged by Napoleon's dramatic invasion of Egypt two decades earlier,

'Egyptomania' was catching on in Britain as it had in Paris. The venue, the Egyptian Hall, was decorated with Egyptian motifs, two statues of Isis and Osiris, and hieroglyphs.

On display to the public was a magnificently carved and painted one-sixth scale model of an ancient Egyptian tomb, which had been discovered four years earlier in the area of ancient Thebes (modern Luxor), later to be known as the Valley of the Kings. At the inauguration ceremony, the tomb's Italian discoverer, Giovanni Belzoni – a former circus strongman turned flamboyant excavator of Egypt – appeared wrapped in mummy bandages before a huge crowd. However, he was obliged to admit that

he did not know who was buried in the tomb, or when, because no-one could read hieroglyphs.

Ancient Egypt was as celebrated in ancient Athens and Rome as it was in 19th-Century Paris and London. In fact, it has exerted a powerful influence on the world of learning for well over two millennia, beginning with the Greek historian Herodotus, who travelled in Egypt around 450 BC. In his *Histories*, Herodotus identified the pyramids at Giza as places of royal burial, and provided important information about the process of mummification. Yet his works were of little or no help to 19th-Century scholars in understanding ancient Egyptian writing, for in classical antiquity, hieroglyphic writing fell into disuse. No Greek or Roman writer could read hieroglyphs, either.

The reason was that the ancient civilisation described in the hieroglyphs, founded before 3000 BC, went into eclipse in the second half of the first millennium BC, when Egypt was conquered – first by Persians, and then by Macedonian Greeks under

Alexander the Great in 332 BC. For three centuries Egypt was ruled by the Greek-speaking Ptolemaic dynasty, named after Alexander's general, Ptolemy I – one of whom created the Rosetta Stone in 196 BC.

This ended with the death of Cleopatra VII and the Roman occupation in 30 BC, which lasted until AD 395. Thereafter, Egypt was ruled first by Coptic Christians, then by Muslims, until the time of Napoleon. Spoken Coptic was descended from the language of ancient Egypt, but written Coptic was not hieroglyphic; it was entirely alphabetic, like Greek and Latin. Nevertheless, the Coptic language would prove invaluable in reading the hieroglyphs by providing approximate pronunciations for ancient Egyptian words.

SACRED WRITINGS

Greek and Roman authors generally credited Egypt with the invention of writing, as a gift from the gods. They thought that hieroglyphs – the word means 'sacred writings' –





How do we know?

Ancient hieroglyphs have been well preserved in the spectacular Luxor Temple

> IN A NUTSHELL

Napoleon's Egyptian campaign in 1798 sparked a wave of interest in ancient Egypt during the early 19th Century - and his troops' discovery of the Rosetta Stone eventually enabled linguists to decipher the hieroglyphics whose meaning had been hidden for over a millennium.

The first 'scientific' step in deciphering hieroglyphs came from an

some hieroglyphs might be, at least in some measure, what he called *notae phoneticae*, Latin for ‘phonetic signs’, representing sounds rather than concepts in the Egyptian language.

And now we reach a turning point: the arrival of Napoleon Bonaparte's invasion force in Egypt in 1798. Fortunately for science, this force was almost as interested in knowledge as in conquest. A large party of scholars and scientists known as 'savants', including the mathematician Joseph Fourier, accompanied the army. When military engineers discovered the Rosetta Stone in July 1799 while rebuilding an old fort in the Nile Delta, the












inscription was in Greek, the column inscription in hieroglyphic. In the Greek, the names of Ptolemy and Cleopatra were mentioned; in the hieroglyphs, only two cartouches occurred – presumably representing the same two names. One of the cartouches was almost identical to one form of the cartouche of Ptolemy on the Rosetta Stone (B).

There was also a shorter version of the Ptolemy cartouche on the Rosetta Stone (C). Champollion decided that the shorter cartouche spelt only Ptolemy, while the longer (Rosetta) cartouche must have an additional

royal title. Following Young, he then proceeded to guess the phonetic values of the hieroglyphs in the second, unknown cartouche on the Philae obelisk (D).

There were four signs in common, those with the values 'l, e, o, p', but the phonetic value 't' was represented differently. Champollion deduced correctly that the two signs for 't' were homophones, that is, different signs with the same phonetic value (compare in English, Gill and Jill, recognize and recognise). He now had the basis for an essentially correct hieroglyphic 'alphabet'.

[illegible][illegible]

c		p	
l		t	
e		o	
o		l	
p		m	
a		e	
t		s	
r			
a			

D) The phonetic values of the hieroglyphs spelling Cleopatra and Ptolmes (Ptolemy)

officer in charge quickly recognised the importance of its three parallel inscriptions and sent the Stone to the savants in Cairo.

That October, Napoleon himself, recently returned from Egypt, told the National Institute in Paris: "There appears no doubt that the column which bears the hieroglyphs contains the same inscription as the other two. Thus, here is a means of acquiring certain information of this, until now, unintelligible language."

From the moment of discovery, it was clear that the bottom inscription on the Rosetta Stone was written in the Greek alphabet and the top one – unfortunately the most damaged – was in Egyptian hieroglyphs with visible cartouches. Sandwiched between them was a script about which little was known. It plainly did not resemble the Greek script, nor did it appear to resemble the hieroglyphic script above it, not least because it lacked cartouches. Today we know this script as 'demotic', a cursive form of ancient Egyptian writing, as opposed to the separate signs of hieroglyphic.

The first step was to translate the Greek inscription. This turned out to be a legal decree issued at Memphis, the principal city of ancient Egypt, by a council of priests assembled on the anniversary of the coronation of Ptolemy V Epiphanes, on 27 March 196 BC. The Greek names Ptolemy, Alexander and Alexandria, among others, occurred in the inscription.

THE BOTTOM LINE

The eye of would-be decipherers was caught by the very last sentence of the Greek. It read: 'This decree shall be inscribed on a stela of hard stone in sacred and native [ie, hieroglyphic and demotic] and Greek characters and set up in each of the first, second and third [-rank] temples beside the image of the ever-living king.' In other words, the three inscriptions – hieroglyphic, demotic and Greek – were definitely equivalent in meaning, though not necessarily 'word for word' translations of each other.

Since the hieroglyphic section was broken, it was at first ignored in favour of the demotic section, which was almost complete. In 1802, two scholars, a French Orientalist called Silvestre de Sacy and his Swedish student Johann Åkerblad, both adopted similar techniques. They searched for

CAST OF CHARACTERS

The scholars who, step-by-step over several decades, rediscovered a long-lost language



Silvestre de Sacy (1758-1838) was a professor at the Special School of Oriental Languages in Paris, where he became the most influential teacher of Champollion. He attempted to decipher the Rosetta Stone without success, but his proposal that the Stone's hieroglyphic cartouches might be written in an alphabet proved important.



Johann Åkerblad (1763-1819) was a Swedish diplomat and student of de Sacy. He compared the Egyptian demotic and the Greek inscriptions on the Rosetta Stone, and concluded that demotic appeared to be an alphabet like Greek. Although this was not so, he correctly identified certain names and words in demotic as alphabetic.



Joseph Fourier (1768-1830) was a French mathematician famous for his analysis of heat. He accompanied Napoleon Bonaparte on his invasion of Egypt and returned to France with a collection of antiquities that inspired the young Champollion to investigate Egyptian scripts.



Thomas Young (1773-1829) was an English polymath who practised as a physician in London and is known for his interference of light experiment as well as for his linguistics. He built on the ideas of de Sacy and Åkerblad, realised that demotic was derived from hieroglyphic and deduced a hieroglyphic 'alphabet' that proved partially correct.



Jean-François Champollion (1790-1832) studied Egyptian scripts from his teenage years in Grenoble. He rejected his English rival Young's 'alphabet' until 1822, when new evidence from Egypt led to his breakthrough discovery: that the hieroglyphic and demotic scripts are a complex mixture of phonetic and non-phonetic signs.

TIMELINE

Hieroglyphs were used for over 3,000 years, then forgotten about for well over a millennia

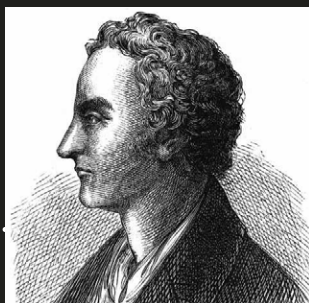
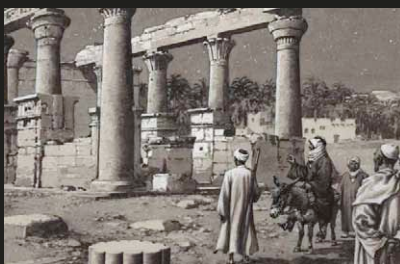


The ancient Egyptians invent **hieroglyphic writing** and use it for more than three millennia: the last inscription known is dated AD 394. Knowledge of how to read hieroglyphic was then completely lost until 1822.

3100 BC

1799

The **Rosetta Stone** is discovered in Egypt at Rosetta (modern Rashid) by soldiers from Napoleon Bonaparte's army. Dating from 196 BC, it carries three inscriptions: two in Egyptian scripts and one in Greek.



Thomas Young publishes a long article, 'Egypt', as a supplement to the *Encyclopaedia Britannica*. In it, he proposes a **hieroglyphic 'alphabet'** and reads many hieroglyphic names and words, some correctly.

1819

1822

Jean-François Champollion, at a celebrated lecture in Paris, shows how to read dozens of **hieroglyphic names** from the Greco-Roman period of Egypt, such as Caesar, Cleopatra (depicted right) and Ptolemy.



Champollion's *Précis Du Système Hiéroglyphique Des Anciens Égyptiens* extends his system back to the **early pharaohs**. Though brilliant, parts are erroneous, leading to bitter controversy.

1824

→ a name, in particular Ptolemy, by isolating repeated groups of demotic symbols located in roughly the same position as the 11 occurrences of Ptolemy in the Greek inscription. Having found these groups, they noticed that the names in demotic seemed to be written alphabetically, as in the Greek inscription – that is, the demotic spelling of a name apparently contained more or less the same number of signs as the number of alphabetic letters in its assumed Greek equivalent. Matching demotic sign with Greek letter, they drew up a tentative alphabet of demotic signs. By then applying this tentative alphabet to the rest of the inscription, certain other demotic words, such as 'Greek', 'Egypt' and 'temple', could be identified. It looked as though the entire demotic script, not just the names, might be alphabetic like the Greek inscription.

But in fact demotic was not an alphabet, nor was it wholly unrelated to hieroglyphic, as de Sacy and Åkerblad thought. But de Sacy deserves credit for a useful suggestion in 1811: that the Greek names inside hieroglyphic cartouches, which he assumed must be those of rulers like Ptolemy, Alexander and so on, might be written in an alphabet, as they almost certainly were in the demotic inscription. The same technique, he knew, was used to write foreign names in the Chinese script, which was also thought (wrongly) to have no intrinsic phonetic component.

ALPHABET COUP

The next step was taken in 1815 by an English scientist, Thomas Young, a polymath with interests so diverse that he has been called "the last man who knew everything". Following de Sacy's idea, Young tried to match the letters 'p, t, o, l, m, e, s' in Ptolmes, the Greek spelling of Ptolemy, with the hieroglyphs in the cartouche spelling the name of the ruler. After applying the same technique to the name of a Ptolemaic queen, Berenice, Young had a tentative hieroglyphic 'alphabet', which he published in the *Encyclopaedia Britannica* in 1819. Many of his sign identifications were correct, but some were erroneous.

Young took one other crucial step. By painstaking comparison of the hieroglyphic and demotic inscriptions in the Rosetta Stone and other inscriptions, he showed that demotic

NEED TO KNOW

Key terms and ideas referred to in this feature explained

1 CARTOUCHE

French for 'cartridge', the word also applies to the oval rings enclosing certain groups of hieroglyphs – generally names and titles. It was coined by French soldiers in Egypt with Napoleon, because the oval rings reminded them of the shape of their gun cartridges.

2 DEMOTIC

Demotic script was derived from the far more ancient hieroglyphic script and used from about 650 BC. The standard script by the time of the Rosetta Stone, it is a cursive script with joined-up letters, suitable for handwriting, unlike the monumental hieroglyphic.

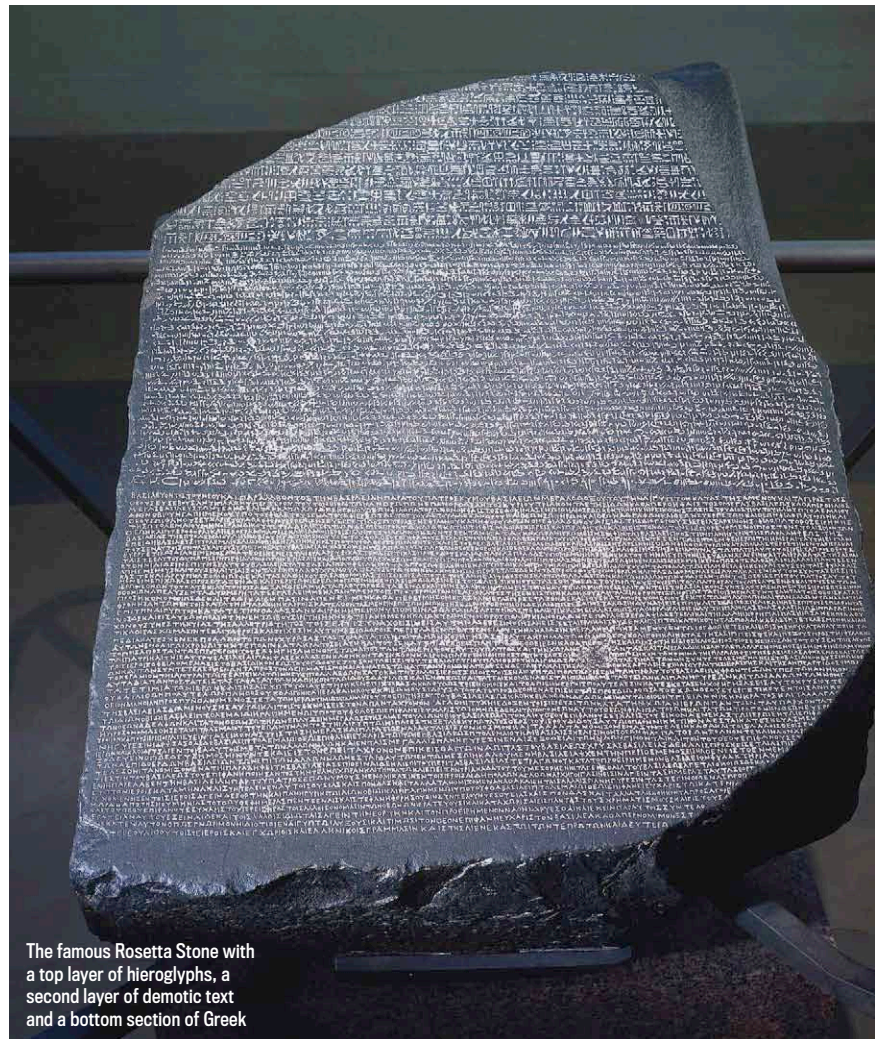
3 PICTOGRAM

Pictograms are semantic signs that are pictorial in origin – think of the signs on toilet doors. However, pictograms can become unrecognisable over time, as in demotic. Many also come to represent simple sounds: in the pictograms of the hieroglyphic 'alphabet', for example, the 'hand' pictogram stands for 'd'.

signs were derived from hieroglyphic signs, contrary to the claims of earlier scholars. In other words, Young could trace how the pictographic hieroglyphs, showing people, animals, plants and objects of many kinds, had developed into their abstract, cursive equivalents in demotic.

From this, Young correctly concluded that demotic consisted of "imitations of the hieroglyphics... mixed with letters of the alphabet". It was neither a purely symbolic script nor an alphabet, but a mixture of the two. However, this remarkable insight did not lead Young, still under the spell of the classical writers, to take the next logical step. The idea that the hieroglyphic script as a whole – not just the cartouches – might be a mixed script like the demotic script, was to be the revolutionary breakthrough of Jean-François Champollion.

Champollion, as a schoolboy, had been inspired by French physicist and mathematician Joseph Fourier.



The famous Rosetta Stone with a top layer of hieroglyphs, a second layer of demotic text and a bottom section of Greek

Fourier became prefect of Grenoble on his return from Egypt and showed the teenager his collection of antiquities, including inscriptions, around 1805. Champollion became absorbed in the problem of the hieroglyphs. Later, in Paris, he was taught by de Sacy, whose frustration with the problem and Young's subsequent progress turned Champollion's quest into an obsession with beating his English rival.

The essential clue came in 1822, from a newly discovered cartouche containing the name of Cleopatra. Champollion now had a hieroglyphic 'alphabet', mostly correct, that allowed him to translate the names of dozens of rulers including Alexander and Ramesses. Over the next year or so, Champollion analysed the daunting combination of phonetic and non-phonetic signs in the hieroglyphic script. In 1824, he wrote: "Hieroglyphic writing is a complex system, a script all at once figurative, symbolic and phonetic in one and the

same text... and, I might add, in one and the same word."

When Tutankhamun's cartouche was discovered in 1922 and deciphered thanks to Champollion's work, it turned out that the 'chick' pictogram was a phonetic sign for the vowel 'u', the 'three-handled cross' stood for the word 'ankh' (or 'life') and the 'shepherd's crook' was a symbol meaning 'ruler'. Thanks to our understanding of hieroglyphs, the secrets of a great civilisation could now begin to be uncovered. ■

Andrew Robinson is a science writer and the author of *Cracking The Egyptian Code*

Find out more

Discover more about the Rosetta Stone and many other aspects of Egyptology at this dedicated BBC History website www.bbc.co.uk/history/ancient/egyptians

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PICK OF THE MONTH



Iain Stewart asks if fracking will satiate our hunger for fossil fuels



Horizon returns

→ WE ARE THE only species with a penchant for novelty ties and Morris dancing, yet we share 99 per cent of our DNA with the chimpanzee. So, what does make us human? In this new *Horizon* series, Dr Alice Roberts sets out to find the answer, but like the true pro she is, completes her quest whilst heavily pregnant. She meets baby chimp Lopor, who at less than a year old is already walking and semi-independent. Facing the prospect of a high-maintenance human baby, Roberts ponders our differences. We're both intelligent but in different ways, as Roberts realises to her cost when she's outwitted by a chimp in a peanut test.

But with 100 billion nerve cells 'chattering' to each other via 100 trillion connections, our brains are still head and shoulders above these hirsute show-offs. We boast 40 per cent more connections than any other primate. These links are being mapped by neuroscientists – a task expected to take 4 million years.

While she waits for the technology to speed up, Roberts is faced with another predicament. The

obstetric dilemma is not about opting for pethidine over an epidural, it's an evolutionary conundrum. The transition to upright walking shrank the birth canal, whilst the trend to increased intelligence boosted brain size. Evolution resolved this 'square peg, round hole' problem by shortening baby's stay in the womb, creating helpless newborns.

If, as her breezy demeanour suggests, Roberts is an optimist, Michael Mosley, in contrast, is a self-confessed worrier. His *Horizon* journey lures him through a seven-week slog towards optimism, as he explores the science of positive thinking. In another episode, Iain Stewart explores how a new technique, fracking, could help meet global energy demands. New life and a solution to the energy crisis – now there's something to be optimistic about.

HELEN PILCHER



The new series of *Horizon* starts on BBC Two on 4 July. Times and dates may vary; check Radiotimes.com

DON'T MISS!



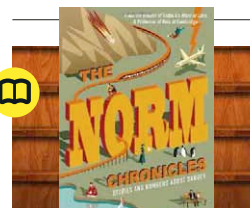
Brains: The Mind As Matter

Grey matter takes centre stage at an exhibition at Manchester's Museum of Science and Industry. **p96**



Darwin's Brave New World

This three-part docudrama follows Darwin's voyage of discovery and the people who helped him. **p98**



The Norm Chronicles

How much risk are you willing to take? Prof Spiegelhalter's stats are here to help in this surprising new book. **p102**



VISIT

EVENTS & EXHIBITIONS

WITH JHENI OSMAN

JULY

Festival Of The Spoken Nerd

Shows in July and August. For dates, venues, prices and booking information see festivalofthespokennerd.com

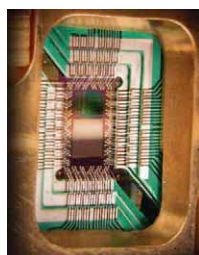


FULL FRONTAL NERDITY is what this comedy trio are all about. Geek songstress Helen Arney, stand-up mathematician Matt Parker and mind-bending trickster Steve Mould host a show of science and silliness. Combining comedy, songs and interactive experiments, the show encompasses everything from discussing the future of artificial intelligence to singing a mathematically correct love song.

4 JULY

Computing With Quantum Cats

Royal Institution, London, 7pm-8.30pm, £10/£7/£5, members free, www.rigb.org



"ANYONE WHO IS not shocked by quantum theory has not understood it," said Niels Bohr in 1958. But now we're on the brink of creating quantum computers. Join astrophysicist John Gribbin as he explains how quantum computing could enable faster than light communication and create unhackable laptops. Teleportation of quantum info is the key. Sadly though, teleporting *people* is still a long way off...

8-21 JULY

Cardiff Science Festival

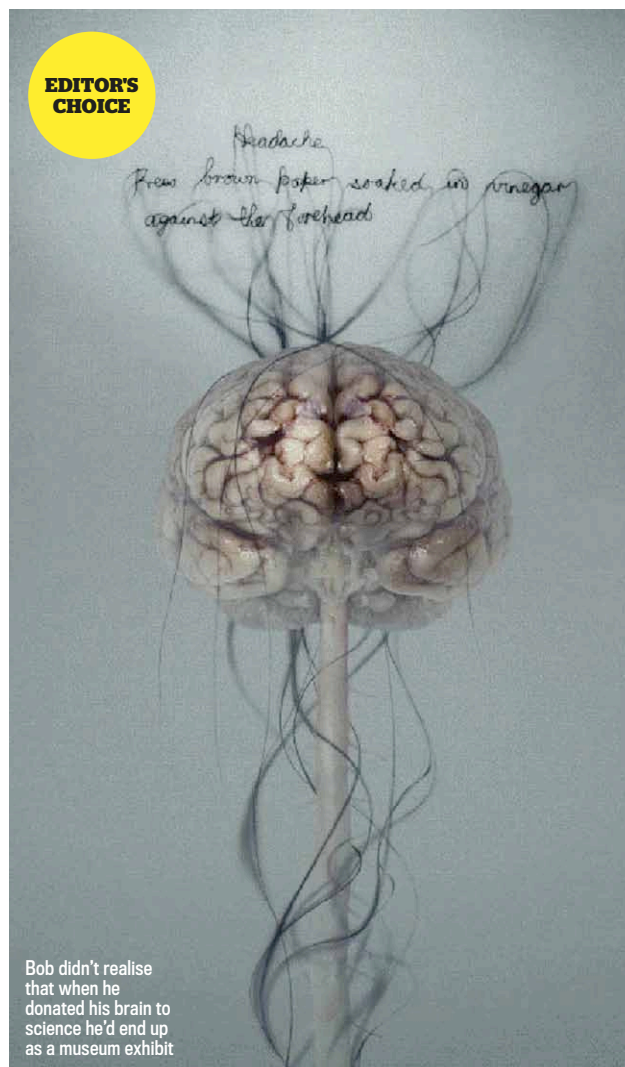
www.cardiffsciencefestival.co.uk



CLARK KENT, BRUCE Wayne and Tony Stark had better watch out. At this festival, 'science magician' Dr Matt Pritchard reveals the science of superpowers. With a PhD in atomic physics and as an associate of the Inner Magic Circle, Matt knows a thing or two about mysterious scientific dimensions. Also at this year's festival are the likes of 'Rock Doctor' Mark Lewney and *The Infinite Monkey Cage* co-presenter Robin Ince, as well as numerous other events and activities.

JHENI OSMAN is a science writer and the author of *100 Ideas That Changed The World* (BBC Books, £9.99)

EDITOR'S CHOICE



26 JULY - 4 JANUARY

Brains: The Mind As Matter

MOSI, Manchester, free, www.mosi.org.uk



IMAGINE BEING GULLIVER in the land of Lilliput and using miniature chopsticks to tie minute, thread-like shoelaces. That's what brain surgery is like. After shaving off hair, drilling through the skull and making a hole in the scalp, brain surgeons perform fiddly operations on living grey matter through a narrow tube known as an endoscope. Neuropathologists get their hands dirty, too - slicing up donated brains to research conditions such as Parkinson's disease and multiple sclerosis.

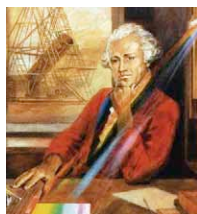
If the mere thought of prodding grey matter makes you squirm, then this exhibition (previously seen at London's Wellcome Collection) might not be for you. But you'll be missing out. Featuring real brains, artefacts and intriguing videos and photos, the exhibition explores what humans have done to brains in the name of medical progress, and the role of technology in our quest to manipulate and decipher this mysterious organ.

Maybe take a sick bag along just in case...

10 JULY - 16 DEC

Making Light Of It

Herschel Museum Of Astronomy, Bath,
herschelmuseum.org.uk



BACK IN THE 1700s, when electricity was barely a glint in an inventor's eye, Georgians relied on rushlights (strips of plant fibre) or ruinously expensive beeswax candles. This exhibition looks at how houses big and small were lit, as well as the light-related scientific discoveries of the day. Key among them is William Herschel's discovery of infrared light, which he found by studying sunlight playing on a prism.

13 JULY

Crocodiles Rock

Natural History Museum, London, 12.30pm
 and 2.30pm, free, www.nhm.ac.uk



WEIGHING THE SAME as an elephant and measuring up to 12m long, you wouldn't want to come face-to-face with the world's largest ever crocodile. But before you start perfecting your zig-zag escape run, don't worry – *Deinosuchus* snuffed it about 73 million years ago. At this talk, find out about this fearsome predator and how modern-day crocs are more closely linked to their prehistoric relatives than any other reptile.

20 JULY

Street Science: Flight

National Waterfront Museum, Swansea,
 12.30pm and 2.30pm, free, booking required,
www.museumwales.ac.uk



EVER BOARDED A flight and wondered how on Earth wings and an engine manage to keep that big heavy tube up in the air? At this talk, science presenter Jon Chase explains why planes don't fall out of the sky as well as how hot air balloons go up, and why parachutes don't work in space.

23 JULY

Emerging Tech For Marine Mapping

National Oceanography Centre, Southampton,
 7pm-8pm, free, to book contact
tem@noc.soton.ac.uk, bit.ly/1aaXNEh



BRIGHT YELLOW TORPEDO-shaped Autosubs have investigated everything from the world's deepest 'black smoker' hydrothermal vent in the Caribbean to mysterious ice caverns under Greenland and Antarctica. Join Dr Russell Wynn, the NOC's Head of Marine Geosciences, on a journey into the deep and discover how new technologies are helping to monitor and protect our oceans.

SPEAKER OF THE MONTH

9 JULY

Greg Foot

Royal Institution, London, 6pm-7.30pm,
 £10/£7/£5, members free, www.rigb.org



Who is he?

Greg is half geek, half daredevil. On TV he's been buried alive and electrocuted, eaten human flesh and made a jet engine bed – driven by The Stig – and he's become the go-to man if you want any perplexing science questions answered. Check him out in his most recent BBC Three series *The Secrets Of Everything*, or on James May's YouTube channel Headsqueeze.

What's he talking about?

His talk's entitled 'Everest: Survival At The Extremes'. After a month at Base Camp, Greg reveals how the research team he was accompanying conducted experiments on themselves and other volunteers at high altitude to help identify new treatments for critically ill patients back home.

31 JULY

Lates: Speed

Science Museum, London, free, www.sciencemuseum.org.uk



LIVE MUSIC, SCIENCE, a pub quiz and absolutely no squealing or face-painting activities in sight (unless you indulge in one too many). What more could you want for a great night out? If you don't know about the Science Museum's programme of 'Lates', you're in for a treat. This event will give you a rush: talks and events include speed dating, a solar-powered eco racing car and a silent disco.



WATCH

TV, DVD, BLU-RAY & ONLINE

WITH TIMANDRA HARKNESS

TBC

Micro Monsters 3D

Sky1/HD & Sky 3D, Saturdays, time TBC



ANYONE WHO HAS a phobia about spiders, look away now... because the latest 3D filming technology has been turned onto our eight-legged friends, and various other creepy-crawlies, to bring them into your living room much larger than life and almost as natural. Some of this series was filmed in the wild, other segments under controlled conditions – though, as the tiny stars soon chewed through the cords suspending them and became overactive in the heat of the studio lights, not quite as controlled as the film-makers had hoped.

1 JULY

Blow Your Mind Monday

National Geographic, 1 July, 9pm



WHAT'S ON YOUR mind? Do you even really know? Robert Llewellyn and former Royal Institution Christmas lecturer Bruce Hood unleash a barrage of experiments, animations, hidden camera tricks and try-this-at-home tests on their experimental subjects – you, the audience. Along the way you may discover that your brain gets up to lots of things you're completely unaware of – though, ironically, you'll be using your brain to find out about them. And of course Professor Hood used his brain to... oh, no wonder they call it *Blow Your Mind*.

1 JULY

Tech Toys

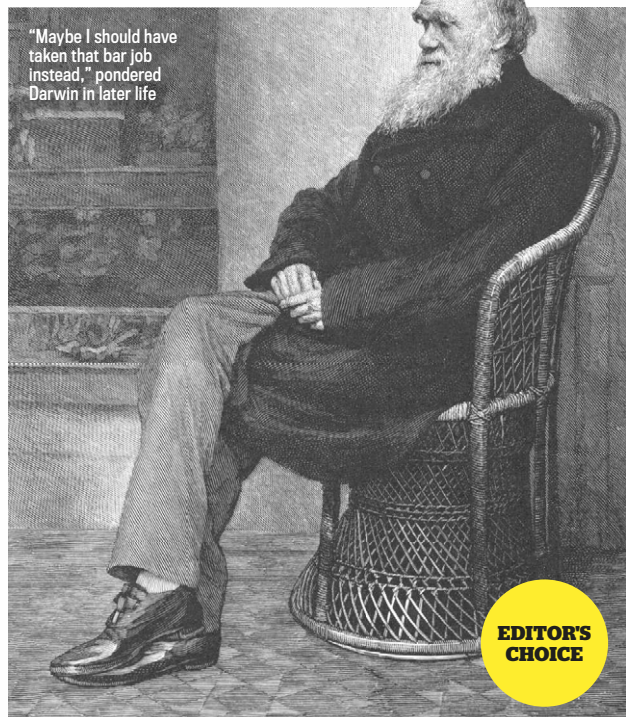
Quest, starts 1 July, 7pm



IT'S THE RETURN of the series that seeks out the world's most desirable gadgets and machines, from watches to private jets. Let's not even kid ourselves that we'll ever buy this stuff, but it's fun to indulge in some fantasy shopping, isn't it? Helicopters and motorcycles, cigars and fine wines... (er, is wine a gadget? – *Ed*) sit back, relax, and imagine you're James Bond.

TIMANDRA HARKNESS is a stand-up comedian and a presenter on BBC Worldwide's YouTube channel Head Squeeze

"Maybe I should have taken that bar job instead," pondered Darwin in later life



EDITOR'S CHOICE

JULY TBC

Darwin's Brave New World

H2, starts 18 July, 9pm

→ LIKE MANY YOUNG men today, Charles Darwin wanted to see a bit of the world before settling down, and persuaded his dad that a round-the-world trip would be good for him. But by the time young Charles got to the southern hemisphere, he was well on the way to gathering the raw material for a theory that would shake the world.

This three-part drama documentary brings in often neglected parts of Darwin's formative voyage and the people who helped him. His observations and assiduous collecting in the Galapagos Islands are well known, but young Charles also went on to

Australia and New Zealand. As well as Darwin and his family, Captain Fitzroy and intellectuals such as Thomas Huxley and Alfred Russel Wallace, the characters include aboriginal and Maori locals whose knowledge of their native flora and fauna must have opened the young Darwin's eyes to a much wider spectrum of natural variation.

But, like many young men today, Darwin found on his return that the real work was just beginning. Getting his controversial theory into scientific form, writing it up and publishing it as *On The Origin Of Species* would take up many years of his life.

5 JULY

Meteorite Men

Quest, starts 5 July, 8pm



A THIRD SEASON of the series that sends Geoff Notkin and Steve Arnold around the planet in search of visitors from outer space. True, these visitors are inanimate lumps of mineral, but when you consider that they're billions of years old and among the rarest natural objects on the planet, they're still pretty cool. Among the missions in this series, they tackle a 5,000-year-old crater in Poland, with high-tech metal detectors and a strict time limit.

7 JULY

The Numbers Game

National Geographic, starts 7 July, 8pm

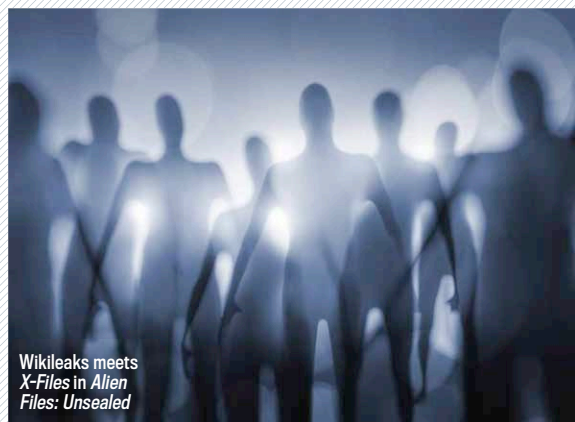


STATISTICS ARE SEXY, and this series proves it. In the first show, 'When Will You Die?', data scientist Jake Porway proves that what doesn't kill you really might make you stronger, and reveals the dangers that lurk in surprising places. The next two programmes deal with making your first million and how not to go crazy. Remember us when you're sunbathing on that superyacht (and watch out for sharks).

9 JULY

Alien Files: Unsealed

H2, starts 9 July, 9pm



Wikileaks meets
X-Files in *Alien
Files: Unsealed*

➔ IF YOU ALWAYS suspected that the government was keeping secret files on UFO sightings, you may be very excited about this. In 2011 the Freedom of Information Act made lots of documents available to the public, and this series draws on those records to re-examine stories of alien sightings, UFOs and even abductions from around the world. The role of Wikileaks and social media also comes under scrutiny, with hints at state cover-ups.

DVD & BLU-RAY



Coast Series 8

BBC, £22

THE LATEST SERIES of *Coast* sees Nick Crane joined by experts to explore Britain's islands and estuaries. Neil Oliver, Tessa Dunlop and Miranda Krestovnikoff are among those telling the stories of the Red Clyde, the freshwater voles that took to sea and the abandoned islands of Scotland.



Complete Everest Collection

Discovery, £24.99

MOUNT EVEREST HAS been well and truly conquered, but that doesn't make it any less awe-inspiring. Celebrating the 60th anniversary of the first summit, this DVD set includes documentaries shot in 2006 and 2007, one of which features cameras strapped to Sherpas' helmets.



MythBusters: season 4

Discovery, £59.99

URBAN MYTHS, MOVIE plotlines and pub rumours are put to the test by Adam Savage and Jamie Hyneman with their trademark special effects flair. Expect danger, destruction and cruelty to crash test dummies. This 30-episode box set includes the Diet-Coke-&-Mentos trick and "everyone's favourite", the exploding pants.

7-13 JULY

The Sky At Night

BBC One/Two/Four, various times



IN A SUMMER solstice special, Chris Lintott and the team investigate our nearest star, and why midsummer day is so special to astronomers. And to druids, as Chris finds out at Stonehenge. Was it really the oldest observatory in Britain or, as *Focus* staff have always suspected, the first sports stadium, abandoned when it wasn't ready in time for the 3,000 BC Olympics?

21 JULY

Bugs, Bites And Parasites: Tropical Diseases Uncovered

Discovery, starts 21 July, 10pm



LUCKILY, THIS SERIES goes out after most people's teatime, because you won't want to be eating while you watch medics deal with gruesome and often life-threatening infestations. Eggs laid by maggots in a tourist's ear? Liver flukes breeding under the skin (pictured)? They're trivial compared to entire villages laid low by parasites.



LISTEN

BBC RADIO PROGRAMMES

WITH TIMANDRA HARKNESS

2 JULY

Human Zoo

BBC Radio 4, starts 2 July, 3.30pm

IT'S THE RETURN of the series that looks to science to explain human behaviour. Michael Blastland and psychologist Nick Chater of Warwick Business School take their subject matter from stories all around us, whether in the news or in everyday life, and ask if experimental psychology can enlighten us about ourselves.

8 JULY

A Guide To Garden Wildlife

BBC Radio 4, starts 8 July, 9.30am

EVERYTHING YOU NEED for a safari in your back yard. Brett Westwood and naturalist Phil Gates venture into a Bristol garden, starting with the pond. Learn to identify waterboatmen, froghoppers (pictured) and leafcutter bees from their sound, habits and appearance.



One day you're hopping frogs, the next you've got your own show on Radio 4

20 JULY

The Sacrifice: A Discovery Special

BBC World Service, 20 July, various times

TEN YEARS AGO, the SARS virus claimed lives across the world and threatened to start a

pandemic killing thousands more. Doctor Kevin Fong revisits the fatal path of Severe Acute Respiratory Syndrome, from Hanoi to Canada via Hong Kong, and talks to those who were on the front line. Some doctors and nurses paid with their lives, and their sacrifice bequeathed lessons which are still helping protect our interconnected world against new infectious killers.

31 JULY

Techno Odyssey

BBC Radio 4, starts 31 July, time tbc

RADIO IS UNIQUELY able to explore spaces that we can't access physically. In this miniseries, Paul Farley takes us into the internet of fibre optic cables that cross oceans, the world in which cash circulates from ATM to hand to bank vault, and inside the human body, where heart valves need no longer be the ones that nature gave us. Weaving together the voices of their inhabitants, the sounds of the technology and the poetry they inspire, he immerses us in these secret worlds.

SUNDAYS JULY

The Science Hour

BBC World Service, Sundays, 3pm

A weekly round-up of what's new in science, health and technology, presented by one of the BBC's Science team, which includes Gareth Mitchell, Claudia Hammond and a BBC News correspondent. They examine the latest research, the hottest scientific controversies and the impact they might have on our lives in future – all packed into an hour of radio as concentrated and tasty as space food.



TOUCH

SMARTPHONE & TABLET APPS

WITH CHRISTOPHER PHIN



Sky Guide: View Stars Night Or Day

iPhone, iPad, iPod touch
Fifth Star Labs LLC, £1.49

THERE ARE LOTS of apps that do what this does – you point your device up and move it around to identify stars and other celestial objects – but this one adds real polish. It's very pretty, there's lots of information as well as links to more, and we love the option of searching for something and have it direct you to where it is in the sky, though we miss Star Walk's night vision-friendly red mode. Still, this app is a real treat – and a bargain.



FocusTwist

iPhone, iPod touch
Arqball, £1.49

YOU'D BE FORGIVEN for thinking digital cameras are old hat. But some companies are still innovating hard, such as Lytro, whose cameras let you refocus photos after you take them. FocusTwist brings that to your iPhone for 0.5 per cent of the cost – kind of. What it does is to take photos at different focal planes and layer them up, so that whether you're viewing them in the app or sharing them on its website, you can click on different parts to focus on them. It's not perfect, but it's impressive when it works.



ISS Detector

Android 2.2 or later
RunaR, Free

SEEING THE INTERNATIONAL Space Station tearing across the sky is always exciting – the trick is knowing when to look up. This app counts down to the next pass, and you can have it alert you when the ISS is about to hove into view. For £1.50, you can also track other famous objects such as the Hubble Space Telescope. We'd have liked more control over alerts, but you can't put a price on seeing a space station hurtling overhead – which may be why it's free!

CHRISTOPHER PHIN is the editor of MacFormat magazine



PLAY

CONSOLE & COMPUTER GAMES

WITH NEON KELLY



Gunpoint

PC; Tom Francis, £TBC

RICHARD CONWAY IS a freelance spy with a talent for leaping face-first through plate glass windows. As he burgles his way through a series of corporate fortresses, he hacks the security systems to work in his favour. Say you encounter a camera linked to an alarm: rewire the CCTV to a locked door, and it'll open the way forward instead. Join a guard's gun to an electrical socket, and he'll fry when he pulls the trigger. *Inspector Gadget* meets *Mission Impossible* in this wryly brilliant action-puzzler.



Monster Hunter 3 Ultimate

Wii U; Capcom, £38.99

GOOD NEWS, EVERYONE: the Wii U finally has a new release that's actually worth playing. The only caveat, of course, is that *Monster Hunter 3 Ultimate* is a mean old playground bully of a game. Still, that's half the point: you start out as a hopeless clod, but after hours of learning from your mistakes – and many more hours of forging new weapons – you'll be a fearsome slayer of giant beasts. Until then, you're a punch bag for anything with teeth and/or claws. Pretty much everyone, then.



Mario & Luigi: Dream Team

3DS; AlphaDream, £34.99

WHILE MARIO AND his lanky brother will always be known for their platform antics, their RPG outings represent some of their finest moments. This latest effort finds the moustachioed plumber venturing into the dreams of his slumbering sibling. These strange landscapes can then be distorted by tweaking poor Luigi as he sleeps: tugging on his 'tache, for example, might cause a new platform to sprout from the scenery. Such weirdness is par for the course in this series, so expect *Dream Team* to be as mad as a box of frogs.



Your mission: to help these little green Muppet-like critters boldly go where no little green Muppet-like critter has gone before. Quite possibly in a galaxy far, far away...

Kerbal Space Program

PC, Mac; Squad, £17.99



➔ IF YOU'RE SOMEONE who follows the indie games scene closely, then you may already be familiar with Kerbal Space Program – the ever-evolving alpha code has been available online for quite some time. But in light of the project's recent jump to Steam – and seeing as the annual summer games drought is now in full swing – there's never been a better time to explore the inky depths of space.

The Kerbals of the title are a race of goofy little green humanoids with bulging eyes and grand ambitions vis à vis exploring the Universe. As the head of their space programme, it's your job to design and build a rocket that's capable of ferrying them into orbit. In the initial hours of play, this is a two-stage process.

First you construct your craft, snapping together modular components via an editor that resembles an oversized Lego set. When you're satisfied with your handiwork,

you then ready the ship for launch, crank up the engines, and blast off. Depending on your level of competence, your creation will either roar towards the heavens, leaving you with a sense of pride previously reserved for NASA engineers, or blow itself to smithereens in a spectacular cataclysm. Which isn't quite as satisfying.

Despite the game's cutesy aesthetics, the action is actually underpinned by a deeply realistic set of physics simulations. If you're not content to rely on pure luck, then successful ship design relies on your ability to calculate the thrust-weight ratio of your ramshackle craft. Reach outer space and a whole new set of challenges arise – orbital trajectories, gravity wells and the amassed debris from your previous, failed experiments. If you're really skilled, you can even land your shiny new space craft on foreign planets.

Kerbal Space Program is still in development. As such, at this stage it's less a game and more of an elaborate toy. That's by no means a criticism though, and while the developers still have a long list of features to implement, there's already enough here to keep NASA wannabes busy for months.



READ

THE LATEST SCIENCE BOOKS REVIEWED

H Hardback **P** Paperback



The Norm Chronicles Stories And Numbers About Danger

David Spiegelhalter and Michael Blastland

Profile Books **P** £12.99

THE FACTS ABOUT risk often surprise or shock us. Did you know that bananas are radioactive? Eat 200 of them and the radiation dose is equivalent to a chest X-ray, shortening your life by, on average, 11 minutes. And in 2009, government medical advisor Professor David Nutt lost his job for pointing out that horse riding carries about the same overall danger to health as taking ecstasy.

Just as well, then, that journalist Michael Blastland and statistician Prof David Spiegelhalter are on hand to help us pick our way through life's perils, demystifying the slippery concepts of probability and risk in this excellent book.

Each chapter begins with a passage of fiction following the exploits of Norm, a super-rational Mr Average who lives his life by statistics, and his friends: risk-averse Prudence and risk lover Kelvin. Hard facts follow the fiction as the authors dig up data on practically every form of risky pursuit imaginable – from travel, surgery, extreme sports, food and drink to sex, gambling and

asteroids. This in itself is a monumental achievement in data gathering. But if statistical nirvana alone isn't enough for you, it's also a funny and entertaining read.

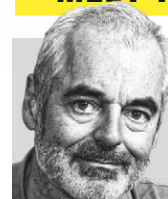
They use a nifty device for comparing risks in different areas: the MicroMort (MM). A risk of 1MM corresponds to a one-in-a-million chance of dying. We are all exposed to a daily dose of 1MM just by going about our business, but other activities add to that. Driving is 1MM per 300 miles; taking the train is a far safer 1MM per 7,500 miles. Running a marathon is 7MM – you'd be better off scuba diving, which comes in at just 5MM. A six-month tour of duty in Afghanistan at the height of the conflict clocked up a hefty 8,500MM – equivalent to driving over 2.5 million miles.

All of which makes this book essential reading before you place your bets in the big lottery of life!



DR PAUL PARSONS is a quantitative analyst and author of *How To Destroy The Universe*

MEET THE AUTHOR



David Spiegelhalter

What's the book about?

It aims to mix fiction and non-fiction, and therefore explore both the 'facts' and the 'feelings' about risk. We've got this guy Norm who tries to be rational about the risks – I think he's based on me, really – and he discovers that he's utterly average. But in contrast he's got these ludicrous friends who react to risks with their guts, either by being ridiculously cautious or outrageously reckless. It gives us a chance to explore both the stats of risk – which is what I've always worked on – and also the human responses to everything we read in the news, from child abduction to being hit by an asteroid.

Why did you decide to write it?

I'm a statistician who works with numbers, but I'm also really interested in stories and how to turn numbers into gripping narratives. Michael [Blastland] is an English graduate and journalist, and he works with stories all the time but also loves numbers. So it seemed a good idea to put these views together.

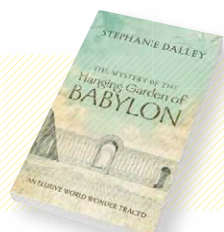
Do I have more chance of winning the National Lottery or of being killed by an asteroid?

Oh, that's a good one! Let me do some sums... there's a one in 14 million chance of winning the National Lottery with one ticket. The National Academy of Sciences worked out that there's about a one in 77 million chance per year of being killed by an asteroid – when averaged over many millions of years. So you've got as much chance of winning the Lottery with one ticket as you have of being killed by an asteroid over a given six-year period. How about that?



MORE ON THE PODCAST

Listen to the full interview with David Spiegelhalter at sciencefocus.com/podcasts



The Mystery Of The Hanging Garden Of Babylon

An Elusive World Wonder Traced

Stephanie Dalley

Oxford University Press **H** £25

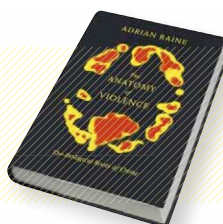
FOR THE ANCIENT Greeks and Romans, the Hanging Gardens of Babylon were one of the Seven Wonders of the World. Said to have been built by Nebuchadnezzar II in the 6th Century BC, the gardens were fed by water from the Euphrates that was somehow lifted onto artificial terraces in the royal palace. Yet no trace of them has ever been excavated.

Stephanie Dalley, an Oxford-based archaeologist, has devoted decades to solving this mystery. With forensic skill, she argues that the Hanging Gardens did exist – but in Nineveh, north of Babylon, in the palace of the Assyrian ruler Sennacherib, who ruled around 700 BC and was renowned for his water engineering. Sennacherib's murals depict raised gardens, and an inscription by him appears to refer to a helical water screw cast in bronze, centuries ahead of Archimedes, who may have borrowed his 'invention' from ancient Egypt.

Although Dalley's case is not watertight, as she admits, it appears that the ancient mystery is now essentially solved. But sadly we shall never know exactly what the wondrous gardens looked like.



ANDREW ROBINSON is the author of *Cracking The Egyptian Code*



The Anatomy Of Violence

The Biological Roots Of Crime

Adrian Raine

Pantheon Books **H** £16

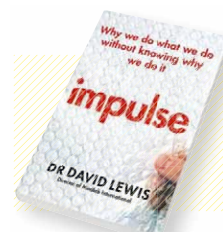
THE AUTHOR WANTS to convince us that crime has biological roots, and that the new field of neurocriminology is an exciting frontier for human knowledge. Judging from this book, though, neurocriminology seems to rely on tired myths of the old biological criminology: that crime results from primitive urges which are poorly contained in certain individuals, races and cultures.

We are presented with little more than titbits of information. Key pieces of the human puzzle are woven into a narrative driven by lazy preconceptions, peppered with lurid details of serial killers and offensive insinuations about various minorities. There is a humanitarian message here about the possibilities for crime prevention and rehabilitation, but it is undermined by the careless language Raine uses. For example, when Raine asserts, "African-Americans have lower verbal IQs," he is pandering to a problematic view of IQ that pays no heed to the fact that IQ scores are something you get from tests you take within a social and historical context, not something you have. Given the history of racist use of IQ research, Raine should be more careful.

This is a badly written, dangerously confused book. Avoid it.



TOM STAFFORD is a psychologist and the co-author of *Mind Hacks*



Impulse

Why We Do What We Do Without Knowing Why We Do It

Dr David Lewis

Random House **P** £12.99

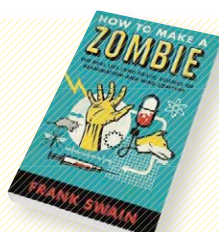
NEXT TIME YOU'RE at the back of a queue, just walk up to the person at the front, say you're in a rush and ask to go first: a study at the City University of New York found that more than 90 per cent of people will wave you ahead. David Lewis recounts this finding, among hundreds of others, to show just how easy it is to bypass the thinking bits of a person and pull on our tendency towards mindless acceptance.

We may think we are in charge of our behaviour – 'we' being the conscious bits of brain that we identify as our 'self' – but in fact we're not. It's those other bits that dictate most of what we do – the primitive, unconscious regions. As Lewis puts it: "Whenever we are motivated by joy or anger, jealousy or envy, love or lust... self-control simply deserts us."

Lewis explains that quick reactions, rather than nuanced responses, have been the key to survival through most of evolution. It's only in this very young age of civilisation that they cause us to wake at 4am and groan at some embarrassing indiscretion. Lewis's book, by showing how everyone is at the mercy of their impulses, may help you get back to sleep.



RITA CARTER is a science writer and the author of *Mapping The Mind*



How To Make A Zombie

The Real Life (And Death) Science Of Reanimation And Mind Control

Frank Swain

Oneworld **P** £11.99

THE THING ABOUT zombies is that they don't stay dead – you only need to look at your TV guide to see that they're back again. According to this field guide, however, reanimated corpses are not confined to fiction. Best grab your cricket bat!

SciencePunk blogger Frank Swain dedicates his book to those researchers dancing on the margin between life and death. Many of his stories are juicier than a ripped-out intestine, as his investigations take us from voodoo 'sorcery' on Haiti to back-alley laboratories where the corpses of executed prisoners jerk and gargle. The most incredible tale is that of a decapitated

dog whose head is kept 'alive' thanks to an artificial circulation machine built by Soviet scientists. Swain also covers mind control, looking at the myriad ways that species – including humans – can be zombified. There are lobotomies, mind-control drugs and parasites that override their hosts' brains.

It's all deliciously macabre and richly informative. You won't need a taste for rotting flesh to enjoy this book, but a strong stomach might help.



IAN TAYLOR is a science journalist

AUGUST
ISSUE

ON SALE 25 JULY

THE INCREDIBLE TRUTH ABOUT TIME

HOW A RADICAL NEW IDEA IS ABOUT TO TRANSFORM
OUR UNDERSTANDING OF THE UNIVERSE



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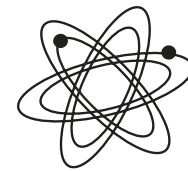
Entrants must be UK residents (inc Channel Islands) aged 18 or over. Immediate Media employees are not eligible to enter. By entering participants agree to be bound by these terms and conditions and that their name and county may be released if they win. Only one entry permitted per person. No responsibility is accepted for lost, delayed, ineligible or fraudulent entries. The closing date and time are as shown on page 112. Entries received after that will not be considered. Entrants must supply their full name, address and daytime phone number. Immediate Media (publisher of *Focus*) will only ever use personal details for the purposes of administering this competition unless you permit otherwise. Read more about the Immediate Privacy Policy at www.immediatemediaco.uk/privacy-policy. The winning entrants will be the first correct entries drawn at random after the closing time. The prize and number of winners will be as shown on the Crossword page. The winners will be notified within 30 days of the closing date by post. Immediate Media's decision is final and no further correspondence relating to the competition will be entered into. The name and county of residence of the winners will be published in the magazine within three months of the closing date. If the winner cannot be contacted within one month of the closing date, Immediate Media reserves the right to offer the prize to a runner-up.

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S	L	O	S	E	V	I	R	K
R	K	L	E	S	A	L	E	S

MINDGAMES PUZZLE
SOLUTION
No cheating! Don't look at
this until you've attempted
the puzzle on p111

SCIENCE FESTIVAL GUIDE



The perfect guide to further learning in 2013

Orkney International Science Festival



World-famous sites provide an island setting for one of the world's oldest science festivals, with a reputation for continually probing the cutting edges of ideas. There is relativity and quantum theory, studies of the history

of science; marine renewables, archaeology and art/science collaborations. The sound of the sea is never far away from events, with local food and drink to the fore. There are talks and outings, concerts and ceilidhs. Venues include a 17th-Century country house and a 12th-Century cathedral.



5-11 September 2013

www.oisf.org

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TechFest In September

TechFest In September, Aberdeen's annual festival of Science, Technology, Engineering and Mathematics, celebrates its 20th anniversary this year: 20 days celebrating 20 years.

The three-week festival, which takes place between September 13th and October 2nd, incorporates an exciting line-up of events and speakers for schools and the public, and is once again being supported by joint principal funders BP and Shell.



13th September - 2nd October

www.techfestsetpoint.org.uk/tis

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The Royal Society Summer Science Exhibition

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2-7 July 2013

royalsociety.org/summer-science

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Manchester Science Festival



Manchester Science Festival invites you to play, create and experiment with your scientific side. The festival brings together a unique blend of art, make-it workshops, performances and big experiences.

These include Ice Lab, an exhibition of innovative and progressive contemporary architecture in Antarctica, and Eye and I, an exploration of human communication: what happens when eyes meet eyes?



26 October - 3 November 2013

www.manchestersciencefestival.com

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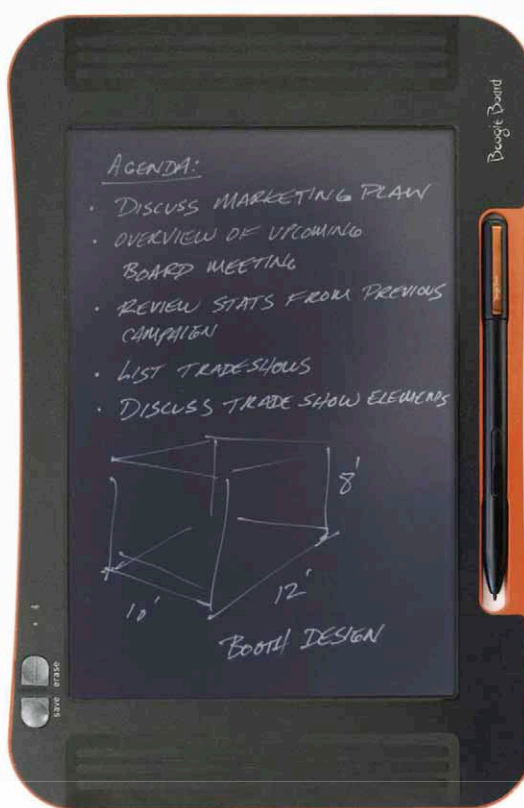

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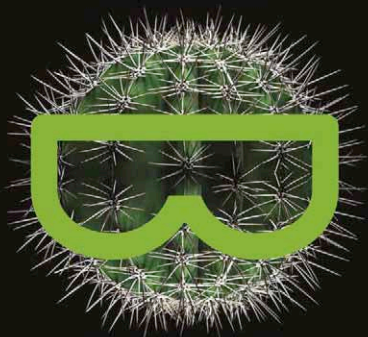
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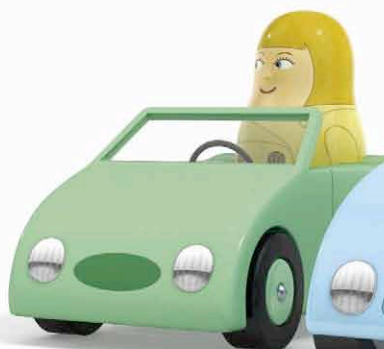
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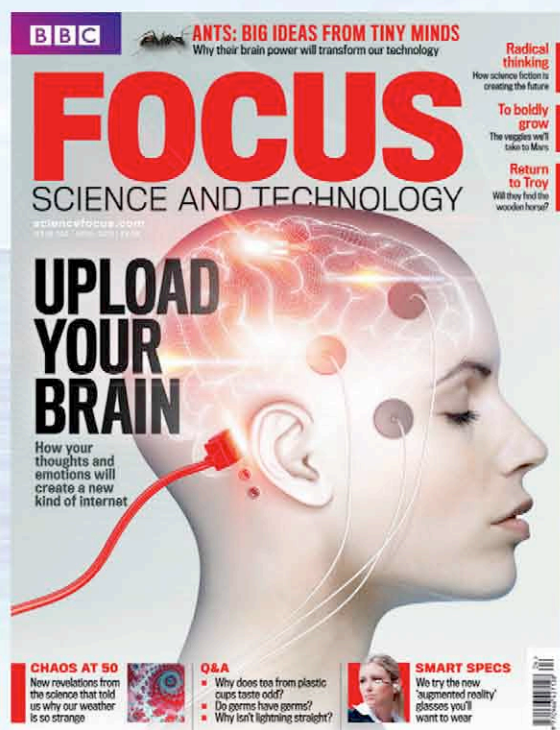
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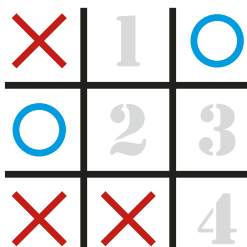
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MINDGAMES

BBC FOUR Pit your wits against these brainteasers by David J Bodycombe, question-setter for BBC Four's *Only Connect*

PRIZE PUZZLE

'Lions and Christians' is a game played as per 'Noughts and Crosses' but the aim is to lose. Which move (1, 2, 3 or 4) should 'noughts' make next?



WIN! WIN! CHASING ICE ON DVD

The first five correct entries win a copy of *Chasing Ice* on DVD (Dogwoof, £10.25).

Post your entry, marked 'Prize Puzzle 257', to: *Focus* magazine, PO Box 501, Leicester, LE94 0AA, to arrive by 5pm on 25 July 2013. We regret that we cannot accept email entries for this competition. See sciencefocus.com/ winners for a list of previous winners and solutions.



See bottom of p104 for terms and conditions. Congratulations to Diana Hancock (West Yorkshire), W Light (Stroud), Susan Aird (Ross-shire), Anne Miller (West Yorkshire) and Rachel Gomez (Leicestershire), who all answered the May's Prize Puzzle correctly to each win a copy of *Through The Wormhole* on DVD.

Q1

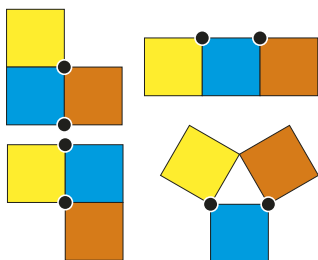
What do the jobs of an aircraft pilot and an American Football player have in common?

Q2

Using the digits 1, 7, 7, 7, 7, the four standard arithmetic operations and parentheses [if needed], form a calculation that results in 100. Now see if you can find a second solution.

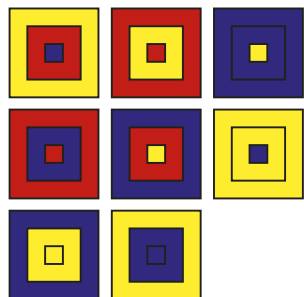
Q3

Three squares are attached by two hinges. Which of these diagrams is the odd one out?



Q4

What should the bottom-right diagram look like?

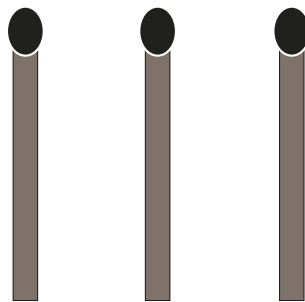


Q5

Remove pairs of identical letters from anywhere in 'THE UNITED STATES ONE HUNDRED DOLLAR BILL' until it's no longer possible. What is appropriate about what remains?

Q6

Here is the number 3 in Roman Numerals. Move one match to increase the number by the smallest possible amount.



Q7

Jason is a disc jockey for a radio station that broadcasts on two different frequency bands. In what way is JASON DJ FM AM newsworthy?

Q8

Complete this Sudoku grid so that every row, column and 3x3 box contains the letters AEFIKLORS in some order. You'll find that one row or column contains a 7-letter English word - what is it?

		F	R		E		A	
	S	O				E		
	L			I			O	
	R		L				E	
F								R
	O				A		K	
	F			E			L	
		E				O	F	
	K		O		F	I		

SOLUTIONS

Q1) They both take satisfaction from successful touchdowns.
Q2) (a) Use fractions: $(7+(1/7)) \times (7+7) = 100$.
(b) Concatenate the digits: $177-77 = 100$.
Q3) The bottom-left diagram is impossible to form without turning the cards over.
Q4) A completely red square. Each row and column contains the components to make a square out of all three colours.
Q5) The letters of BEN remain, and Ben Franklin appears on a \$100 note.
Q6) Place one match horizontally across the top of the other two to form the letter 'P' = 3.1415926...
Q7) It's the first letters of the months of the year, starting in July.
Q8) See illustration on p104.

QUICK QUIZ

Test your knowledge of tropical cyclones

Q1

Complete the sentence:
"Tropical cyclones are areas of low _____ in the atmosphere."

- a) Pressure
- b) Temperature
- c) Winds

Q2

What is the calm centre of a tropical cyclone called?

- a) Hole
- b) Eye
- c) Pocket

Q3

A tropical cyclone is classified as a hurricane if winds reach...?

- a) 54 mph
- b) 74 mph
- c) 94 mph

Q4

What's the name of the scale used to classify hurricanes?

- a) Emanuel-Kantha Hurricane Wind Scale
- b) Saffir-Simpson Hurricane Wind Scale
- c) Murnau-Roberts Hurricane Wind Scale

Q5

Which Atlantic hurricane wreaked havoc in the United States last October?

- a) Katrina
- b) Andrew
- c) Sandy

Q6

In 2004, Catarina became the first hurricane recorded over which body of water?

- a) South Atlantic Ocean
- b) South Pacific Ocean
- c) Southern Ocean

Q7

What name is given to tropical cyclones over the northwestern Pacific Ocean?

- a) Tornadoes
- b) Twisters
- c) Typhoons

ANSWERS:

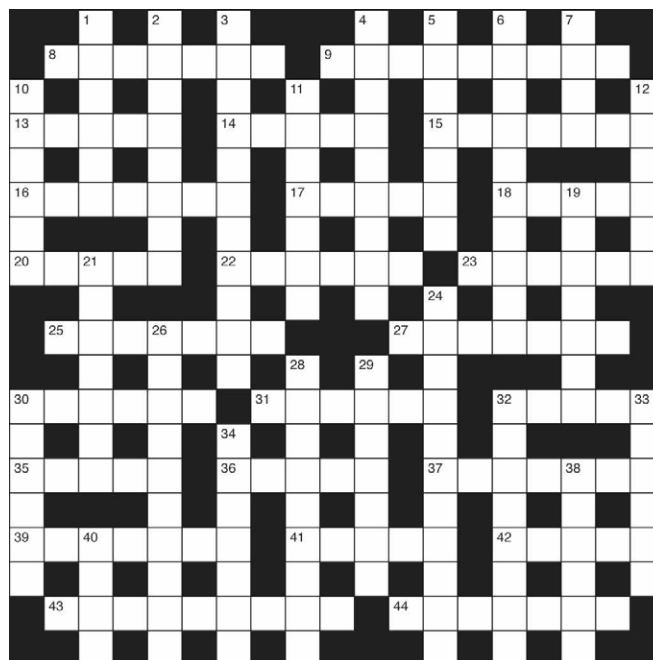
Answers: 1a, 2b, 3b, 4b, 5c, 6a, 7c

YOU ARE A:

- 0-3 Tropical depression
- 4-5 Tropical storm
- 6-7 Perfect storm

FOCUS CROSSWORD No 153

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ACROSS

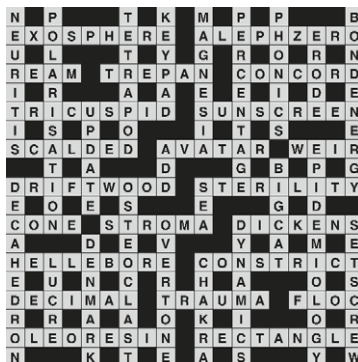
- 8 Time ran out in the tower (7)
- 9 Equation I cart off behind the courtyard (9)
- 13 Father returned and concealed pest (5)
- 14 Strange he accepted discharge (5)
- 15 Severe conditions at the front and highest point (7)
- 16 Doctors lose Scotsman to science (7)
- 17 Mother in a form of madness (5)
- 18 Bill gets credit note for port (5)
- 20 Question radical student about petal arrangement (5)
- 22 Lab equipment is the answer (6)
- 23 Multiform, small type of paper (6)
- 25 Able to concentrate on two things at once (7)
- 27 Element circulates in her with hesitation (7)
- 30 Boy is worried about pressure of examination (6)
- 31 Clean off tip of the knife (6)
- 32 Musical game (5)
- 35 Band gets a type of therapy (5)
- 36 Canoe unsuitable for so much water (5)
- 37 Endless viral disease found at the beach (7)
- 39 Road not affected by adverse conditions (7)
- 41 Department takes height to be the third dimension (5)
- 42 Cope badly with husband for a long time (5)
- 43 Newspaper writer puts supporter first (9)
- 44 Spoken about noise for second, say (7)

DOWN

- 1 Heavy without initial number (6)
- 2 Chap gets to exercise monkey (8)
- 3 Earthly queen has to relax during lawsuit (11)
- 4 Ram only up for treatment of the lungs (9)
- 5 Nowadays learn about a gland (7)
- 6 Tea can flow into strange chain formation (10)
- 7 Fellow takes four home (4)
- 10 Fruit requiring two hands (6)
- 11 The mob struggled to contain eastern insect (3,4)
- 12 They're drawn to decide method of drinking (6)
- 19 Reckon old politician is in appealing surroundings (7)
- 21 River gold found in oxygen and carbon monoxide (7)
- 24 Picture group of friends in a hot place (11)
- 26 Gullet pushes a goo out (10)
- 28 Lass cried about storage unit (9)
- 29 Small church pans out, in spirit (7)
- 30 Swamp transformed to a city (6)
- 32 Spies accept ceremony has right standards (8)
- 33 Notice article boil (6)
- 34 The smell of the city (7)
- 38 Girl takes Chuck around the world (6)
- 40 The origin of botany (4)

SOLUTION TO CROSSWORD No 150

Simon Dean, Kathy Humphrey, Michael Moran, Mike McKeown and Agnes Harter solved issue 254's puzzle and each receive a copy of *Penguins: Spy In The Huddle* on DVD.



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Post entries to *Focus*, Summer 2013 Crossword, PO Box 501, Leicester, LE94 0AA or email a scan of the completed crossword or a list of answers to summer2013@focuscomps.co.uk by 5pm on 25 July 2013. Entrants must supply name, address and phone number. By entering, participants agree to be bound by the terms & conditions, printed in full on page 104. Immediate Media, publisher of *Focus*, may contact you with details of our products and services or to undertake research. Please write 'Do Not Contact' on your email or postal entry if you do not want to receive such information by post or phone. Please write your email address on your postal entry if you would like to receive such information by email.

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INTO THE FUTURE

STEPHEN BAXTER

LAST APRIL, A team of archaeologists from the University of the Witwatersrand in Johannesburg came tantalisingly close to confirming that specimens of an early human ancestor called *Australopithecus sediba*, which they have been studying since 2008, might include scraps of fossilised skin. Preserved in a mud hole for two million years, these would be vastly older than the previous record holder for human skin samples, from mummified remains 10,000 years old.

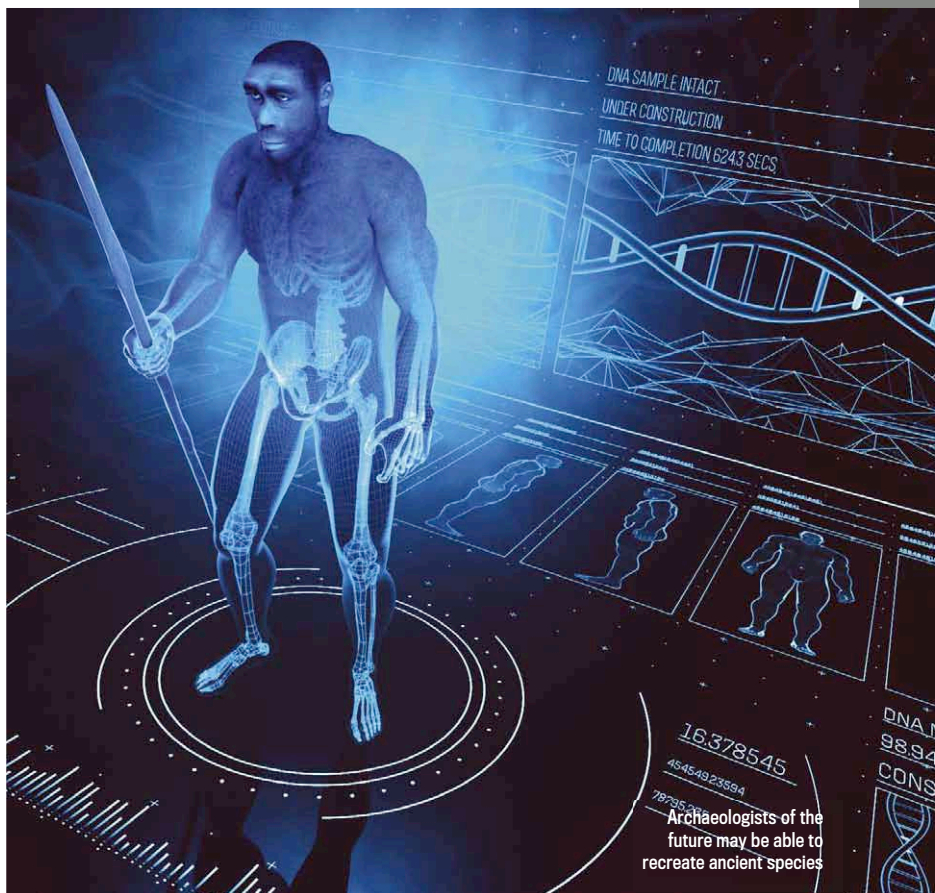
The skin could tell us an extraordinary amount about *A. sediba*: whether they were hairy like the chimps or smooth-skinned and sweaty like us, what colour their skin and hair was, even something about these individuals' state of health. Scales on body hairs can indicate diabetes, for example. Which raises the question: is there any limit to how much archaeology can teach us about the past?

Since the dating of fossils was revolutionised in the 1940s by the use of radiocarbon decay, archaeological techniques have advanced hugely. Nowadays, even fossil retrieval techniques are developing quickly. Fragile fossils can be scanned while still embedded in the rock, and a 3D resin duplicate produced by matter printers. In this way the finest details can be preserved, with no damage caused by removal from the rock matrix.

And, as with *A. sediba*, we can extract ever finer details from fossils. We can discover the colours of feathered dinosaurs from studying the shape of tiny organs called melanosomes, which produce pigment. We can tell what our own hominid ancestors ate from wear patterns and plaque on their teeth, and from the incorporation of trace elements in their bones.

The analysis of DNA is another source of archaeological data. The remains of Richard III in Leicester were identified through a DNA match with living relatives. Analysing the DNA we all share has even allowed us to identify wholly new kinds of hominid who have left barely any fossil traces, such as the Denisovans, of whom fragmentary bones were discovered in Siberia, and who have been identified as ancestors of modern humans in Oceania and Australasia through the traces they left in human DNA through cross-breeding.

In principle, how much of the past could be recovered? In *The Light Of Other Days*, my collaborative novel with Sir Arthur C Clarke, we described a 'past viewer' based on wormholes – flaws in space and time that can connect two points separated by time as well as space. Perhaps we could retrieve some data by peering through such flaws; maybe visual glimpses of past scenes unscrambled from light heavily distorted by its passage through the wormhole.



“We can extract ever finer details from fossils. We can tell what our ancestors ate from plaque on their teeth”

Or maybe some day we will be able to learn from studies made by others; alien visitors who – like the monolith-builders in the movie *2001: A Space Odyssey* – may have visited our Earth in our own past. We might recover any records they made, or even samples they took. The *Doctor Who* episode *Dinosaurs On A Spaceship*, for instance, featured a space ark containing otherwise-extinct creatures – we ourselves already have film records of extinct creatures such as the Tasmanian wolf to bequeath to future generations.

In the end, however, it is more satisfying to imagine the recovery of the past continuing as it has so far, solely through human efforts and ingenuity – and it is hard to put a limit on how much we will ultimately be able to recapture.

As HG Wells wrote, in the 1921 story *The Grisly Folk*: “A day may come when the great beasts of the past will leap to life again in our imagination, when we shall walk again in vanished scenes, stretch painted limbs we thought were dust, and feel again the sunshine of a million years ago.” ■

STEPHEN BAXTER is a science fiction writer whose books include *The Science Of Avatar* and the *Northland* series

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